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An Introduction to Relativity in James Joyce's *Ulysses*

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ABSTRACT

Unavailable to Leopold Bloom in 1904, but front page news to Joyce as he scripted *Ulysses*, Albert Einstein's relativity theories superseded Sir Isaac Newton's theories about absolute space, absolute time, laws of motion, and the universal law of gravitation during the period 1905 – 1922. The opposition between Newtonian mechanics and Einsteinian relativity was played out in the newspapers of the time and incorporated anachronistically into Joyce's novel in his characterisation of Bloom, who is not only a metempsychotic reincarnation of the ancient Greek hero Odysseus, but also a metempsychotic anticipation of the greatest scientist of the twentieth century, Albert Einstein. Musing continually on the ultimate nature of time, space, motion, light, and gravitation, Bloom verges on the brink of an Einsteinian epiphany without ever quite achieving one.

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INTRODUCTION

In the course of determining the 100 most influential people of the 20th century, *Time* magazine - after "soliciting nominations from ... editors and journalists around the world, consulting outside experts and historians, and sifting through thousands of suggestions from readers" (Isaacson 4) - chose James Joyce as the most influential writer and *Ulysses* as the century's pre-eminent literary work. Paul Gray, author of the *Time* feature and also of a Ph.D. dissertation on Joyce, observes that "Even before *Ulysses* was published, critics were comparing Joyce's breakthroughs to those of Einstein and Freud"(63). It is the connection with Einstein in particular that is explored in this thesis.

Most people know that the action of *Ulysses* takes place on one day, 16 June 1904. Stuart Gilbert adds that, "the unity of place is as thoroughgoing as that of time" (28). Yet, these two unities are honoured as much in the breach as the observance. After all, the principal character - Bloom - is a metempsychotic reincarnation of the ancient Greek hero, Odysseus. Not so well known - despite Gray's hint - is the fact that Bloom is also an anticipation of the greatest scientist of Joyce's age: Albert Einstein. Thus, ancient Greece and future Europe co-exist with contemporary Dublin in Joyce's book. Gilbert seemed to acknowledge this when he qualified his earlier remarks about unities with the observation that: "Joyce ... always aimed at being a European writer and, in his major works, linked up the local theme with wider references in Space and Time" (93).

Einstein published his special theory of relativity in 1905[1] and his general theory of relativity in 1916[2]. Both theories postdate Bloomsday itself, but were available to Joyce as he drafted *Ulysses*. Robert March has this to say about the relationship of Einstein's theories to Newton's:

> There is no quarrel between Newton and Einstein over the description of ... space-time tracks. What they disagree about is their significance. Newton

[1] The special theory of relativity is not Einstein's original name, but I use it for convenience. The original name is "*Zur Elektrodynamik bewegter Köper* [On the Electrodynamics of Moving Bodies]."
[2] The English translations came later, but I will, overall, use the dates of the original German versions.

> says that the tracks are curved by the action of a force. Einstein insists that no force is necessary: space-time itself is curved (142).

Thus, Newton's concepts are linear and Einstein's concepts are curved, non-linear. Gary Zukav writes:

> According to Einstein's ultimate vision ... a piece of matter *is* a curvature of the space-time continuum! In other words, according to Einstein's ultimate vision ... there is no such thing as "gravity" - gravity is the equivalent of acceleration, which is motion. There is no such thing as "matter" - matter is a curvature of the space-time continuum. There is not even such a thing as "energy" - energy equals mass and mass is space-time curvature (199).

There is in Joyce's *oeuvre* as a whole a movement from linear to cyclical organisation. *A Portrait of the Artist as a Young man*, from its tell-tale opening phrase "Once upon a time" to the adult Stephen's preparation to leave Dublin, exemplifies the former; *Finnegans Wake*, whose end takes us back to its beginning, the latter. *Ulysses* is the transitional text; it gradually abandons linear narration for increasingly curved and cyclical patterns.

Wyndham Lewis, in *Time and Western Man*, wrote:

> In *Ulysses* you have a deliberate display, on a grand scale, of technical virtuosity and of literary scholarship .... This torrent of matter is the einsteinian [*sic*] flux. Or (equally well) it is the duration-flux of Bergson - that is its philosophic character, at all events (102-3).

This "philosophic character", Lewis argues, is the character of a "time mind" or a "time philosophy": "I regard *Ulysses* as a *time-book*; and by that I mean that it lays its emphasis upon, by choice manipulates, and in a doctrinaire manner, the self-conscious time-sense, that has now been erected into a universal philosophy" (84). In *Finnegans Wake*, Joyce took his literary revenge on Lewis, referring to him as "windy Nous (*FW* 56.29) and "wind hound loose"(*FW* 471.21), and - swapping one dimension for another - to his book as "*Spice and Westend Woman*" (*FW* 292.61). Yet, Joyce never refuted Lewis's basic assumption: that *Ulysses* is organised along the lines of Einsteinian time theory, the "universal philosophy" of time established by the special and general theories. Of course, the cyclical pattern of time organisation in *Finnegans Wake* is even more evident than it

is in *Ulysses,* and Einstein's name is alluded to several times in the later text (e.g. *FW* 231.29, 149.28, 126.15, 152.18, 277.18, 305.6, 305.29).

Since Lewis gave the lead so early, one might have expected the discrepancies between Newton and Einstein's time theories to be a fertile field for critical research, especially since the advent of deconstruction. Yet, Udaya Kumar is typical of most deconstructionists when he states in *The Joycean Labyrinth*: *Time Repetition and Tradition*:

> The validity of Lewis's philosophical argument is indisputable. One could argue against a facile identification of the Bergsonian and the Einsteinian notions of time.... However, it is not my purpose to examine these explicitly philosophical aspects of Lewis's argument (57).

Surprisingly, the opposition between Newton's theory of absolute space and absolute time, and Einstein's general theory of relativity with its curvature of space-time seems to hold little appeal for Kumar and other deconstructionists. In the main, recent deconstructionist criticism has emphasised the play of language in *Ulysses*, and left undeconstructed its unity of place and time. Although the critics have frequently alluded to the Newton/Einstein opposition, it has never been explored in depth.

Alan J. Friedman provides an excellent review of the critical literature devoted to scientific issues in *Ulysses*:

> Several literary critics have used the terms "relativity" and "uncertainty principle" in relation to science and *Ulysses*.... Marilyn French ... claims: "Joyce clearly intended to show incertitude as operating in the cosmos as well as the world". Her examples are all the subjects of classical nineteenth-century Newtonian astronomy....
>
> Richard Kain discusses science occasionally throughout his very useful study, *Fabulous Voyager*: "The picture of modern science given in *Ulysses* is that it constitutes a new folklore of a 'believe-it-or-not' nature and that its principal appeal to modern man is as a materialistic aid to wealth or to the saving of effort". The modern science Kain is discussing is not relativity.... Kain's use of the term "relativity" in his final chapter refer each time to single measurements of time or space, with no particular meaning for Einsteinian physics.
>
> Littman and Schweighauser accurately and thoroughly examine the astronomical terms in *Ulysses*. All examples are comfortably nineteenth-century, and Littmann and Schweighuaser suggest mostly direct symbolic uses of that science.

> Wyndham Lewis, in 1927, directly claimed a relation between *Ulysses* and Einstein, but more a spiritual connection than a scientific one....
>
> Avrom Fleishman gives a different direction for searching out connections between *Ulysses* and twentieth-century science: style. Fleishman reasonably points out that the science content of *Ulysses*, set in 1904, should not directly mention Einstein's relativity, which was first published in 1905.... Although Fleishman gives one example from "Ithaca" that he claims is clearly intended to refer to Einstein's cosmology....
>
> Science as style is also the most convincing aspect of Tindall's treatment. He also sees the style as cold, to "project the inhumanity of science." Edward Watson too finds the science of "Ithaca" directed at demonstrating the objective, impersonal style of science, to be contrasted with the romantic, humanistic approach of other chapters.
>
> None of this critical material makes a strong case, at least for me, that *Ulysses* has a specific *content* connection with twentieth-century science.... I think we must wait, at least until *Finnegans Wake*... to find direct evidence of links between the two modern revolutions in science and James Joyce (201-2).

Andrzej Duszenko provides abundant evidence of the theory of relativity in the *Wake* in his article, "The Relativity Theory in *Finnegans Wake*" (*JJQ* 61-70). However, this work does not cover *Ulysses*. Still unpublished, but available May 1998 on the Internet, is a further article by Duszenko with the same title. It is not just a minor revision of the first publication, but provides completely new research on the subject of relativity theory in *Finnegans Wake*.

Thomas Jackson Rice's recent book *Joyce Chaos and Complexity* studies "the interplay of mathematics and science in the formation of James Joyce, literary artist" (xiii) but has little to say specifically about Einstein. Perhaps contemporary critics would see the links between "modern revolutions in science and James Joyce" (Friedman 202) if they were to pay more attention to the links between the former and recent developments in critical theory which, on the whole, Rice deprecates.

Joan Parisi Wilcox identifies one example of non-Euclidean geometry in the opening sentence of "Ithaca" and mentions "Reimann" (645), but makes no link to Einstein, who in fact made extensive use of Reimann's geometry in the general theory of relativity.

Apart from Fleishman's brief reference to Einsteinian cosmology in "Ithaca" (noted above), only two articles deal affirmatively with the links between *Ulysses* and

Einsteinian theory. John Hannay identifies Einstein's relative motion postulate in the movement of Bloom's crumpled paper ball in "The Throwaway of 'Wandering Rocks'". Stephen Whittaker and Francis X. Jordan find that Bloom's musing about light at *U* 4.83-86 hints at relativistic time dilation.

More negatively, M. Keith Brooker, in "Joyce, Plank, Einstein, and Heisenberg: A Relativistic Quantum Mechanical Discussion of *Ulysses*" writes:

> ... Einstein's work on relativity was published during the period 1905-1915, and the experimental verification of the General Theory of Relativity in 1919 made front page news, a fact of which Joyce was no doubt aware. It is not unlikely that Joyce's imagination was kindled by the publicity given Einstein's work ... even if he had no in-depth understanding of the theories themselves (583-4).

Similarly, Mario Salvadori and Myron Schwartzman assert:

> Joyce's knowledge of mathematics and science was relatively limited.... Despite ... his awareness of Einstein's relativity theory ... Joyce's mechanics are totally Newtonian with a strong emphasis on the importance of Newton's gravitational law" (353).

In "The Newtonian Nightmare of *Ulysses*", Alan David Perlis also cautions:

> *Ulysses* is the post-Newtonian mechanical world turned into a nightmare.... Implied in my application of the Newtonian world view is a caution against any facile argument for the novel as an "epic of relativity," or one in which an Einsteinian vision of a world bound by the limits of how we perceive it prevails (195-6).

Long before Derrida - influenced at least to some extent by Joyce - argued that words exist in a state of "incertitude", "mobility", "slippage", and "decentred freeplay" (109-12), Homer described how Telemachus confronted Proteus, "the slippery god of the sea, whose constantly changing shape enabled him ... to elude all attempts to hold and question him" (Blamires 13), until he was finally fixed and forced to give up his truth. Einstein confronted the same problem of the slippage of absolutes into relativity when he deconstructed the Newtonian concept of "absolute space and time" (Wilson 162) and substituted "the curved spacetime of general relativity" (223).

In *Ulysses* too, linear time is subjected to Protean circular patterns, often symbolised by swirls and the ebb and flow of the tide. The reader is, as the critics often remind us, confronted by wave after wave of polyglossia, whereby no single discourse is authoritative or privileged, so anything one particular character might say or do is soon undercut by a conflicting voice, point of view, differing recollection, or ridicule by the "carnivalesque" of the Arranger. In addition, time seems to be continuously shifting under the reader's feet. It is. Joyce's organisation of time is as slippery as Proteus, with constant shifts out of the present, into the past, into the future and back again.

This constant sabotage of Newtonian time by Einsteinian warpage or circular patterning is highlighted in several ways. The text virtually abandons any form of linear organisation after "Wandering Rocks", preferring increasingly circular and cyclical patterns of discourse (though "Nausicaa" is fairly linear). Moreover, there is throughout a constant vacillation between exterior, naturalistic and chronological time and interior, psychological responses to time and reworkings of that time. Most important, for my purposes, the novel's central character, Bloom, is continually on the verge of an Einsteinian epiphany, but clings obstinately to Newtonian principles. In the discussion that follows, the emphasis will be on the last of these motifs: Bloom's unwitting anticipation of Einstein's theories.

A BRIEF HISTORY

The traditional understanding of space and time is modified in Einstein's special and general theories of relativity. Since the two theories were published piecemeal in German and then translated into other languages, the cited publication dates vary somewhat, depending on which of Einstein's works the various biographers, physicists, and authors choose to quote. Beginning with the publication of "*Die Grundlage der allgemeinen Relativitätstheorie*" (Pais 524) on 20 March 1916, the general theory of relativity was Einstein's extension - to include gravitation - of the 1905 special theory, which modified our understanding of space, time, and matter relative to the speed of light. The special theory was first articulated in "On the Electrodynamics of Moving Bodies" published in *Annalen der Physik* September 1905. This article established the relativity principle of space and time. A second paper, "Does the Inertia of a Body Depend upon its Energy-Content?"[3] published on 27 November 1905, promulgated the equation, $E=mc^2$. It literally destroyed Newton's notions of space, time, matter, inertia, and mass. The two papers constitute what later became known as the special theory of relativity. Published in December 1916, "*Über die Spezielle und die Allgemein Relativistätstheorie, Gemeinverständlich*" was Einstein's "most widely known book"; it established the four-dimensional general theory of relativity but the "quadrupole formula" describing "gravitational waves," which rendered obsolete Newton's universal law of gravitation, was not published until "February 1918" (Pais 525).

Support for the general theory of relativity came from Sir Arthur Stanley Eddington's observations concerning gravitation's effect on light during the solar eclipse of 29 May 1919, which were promulgated in the Astronomer Royal's address on 6 November 1919 to a combined meeting of London's Royal Society and the Royal Astronomical Society. The next day a front-page headline in the London *Times* read: "Revolution in Science - New Theory of the Universe - Newtonian Ideas Overthrown". The 10 November headline in *The New York Times,* which read "Lights all Askew in the Heavens - Einstein Theory Triumphs" (Pais 525), marked the emergence of Einstein as a

[3] The German title for this paper is "*Ist die Trägheit eins Körper von seinnem Energiegehalt Abhängig*?"

worldwide celebrity. His later 1921 trip to America in support of international Zionism made him into a media superstar. Rising anti-Semitism in pre-Nazi Germany eventually forced Einstein to emigrate to America, where, over forty years after 1905, he saw the actual proof of his most famous formula, $E=mc^2$: the atomic bomb. At the same time that Einstein's name and theories were constantly in the media, Joyce was drafting *Ulysses* and, I contend, incorporating some of Einstein's accomplishments into the characterisation of Bloom.

NEWTON, EINSTEIN, *ULYSSES*: DEFINITIONS AND COMPARISONS

Einstein's theories are very complicated. Thus, the concepts and terms which are alluded to in some form or another in *Ulysses* require clarification so that Bloom's physics and its relationship to Einstein's physics can be understood. What follows is largely drawn straight out of a description of Einstein's theory in *The Theory of Relativity*[4] by C. Møller, a Professor of Mathematical Physics.

Einstein's special theory of relativity (1905) is special in the sense that it works only for constant and uniform linear motion and excludes gravitation and acceleration. Originally called "On the Electrodynamics of Moving Bodies", it is a theory which seeks to account for all phenomena relating to relative motion. Therefore, it amalgamates Newton's laws of motion, which apply to mechanical objects, with James Clerk Maxwell's equations, which account for the motion of electromagnetic phenomena such as light waves. It mathematically describes the instability of time, space, and mass at high relative velocities. Increasing velocity toward the absolute speed of light, *c*, causes time dilation (the clock paradox which comes up in Stephen's Hamlet theory and Bloom's musings on time in *U* 4.80-6) and the shortening of lengths (the Fitzgerald contraction[5]), and mass tends toward infinity ($E = mc^2$). So mass and energy, spatial distance and time actually all vary in relation to the absolute velocity *c*.

Newton's three laws of motion and his universal law of gravitation assume that things like mass, velocity, and force are discrete quantities which can be measured at any point in absolute time and space. Therefore, Newton's theories are founded on the notions of "absolute", "universal", and "linear" time. Colin Wilson in *The Book of Time* summarises Newton's theory as: "... the idea that time may be likened to a straight line

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[4] Unattributed page references in this chapter/section are to this book of Møller's. The cognate *Ulysses* passages, which are merely noted at this stage in the form of references to the Gabler edition as required by the *James Joyce Quarterly*, will be returned to later in the thesis.

[5] According to Nathan Spielberg, objects in motion contract in length along the line of motion, eventually shrinking to zero at the speed of light. The effect was first suggested "in 1882, [by] two physicists, G. F. Fitzgerald ... and H.A. Lorentz" and "suggested a solution to the dilemma posed by the Michelson-Morley experiment" (225). I will consider Michelson and Morley later in chapter 6 (pp 42-55).

(linear time) and that time flows uniformly in one direction so that 'the future' becomes 'the present'and then 'the past'..."(159). In *Ulysses*, Stephen quotes this theory *verbatim* at *U* 9.383-4.

Newton incorrectly theorised that "All motions may be accelerated or retarded, but the flowing of absolute time is not liable to change. The duration or perseverance of the existence of things remains the same, whether the motions are swift or slow, or none at all" (cited by Wilson 158). Similarly, Newton believed in absolute space, which was theorised as a kind of vacuous, fundamental background to the universe, a place completely at rest, from which it should be possible to measure the absolute motion of a body. Newton wrote, "Absolute space, in its own nature, without relation to anything external, remains always similar and immovable" (Wilson 160-1). In developing the relativity theory, Einstein deconstructed Newton's absolute time and absolute space, destroying the foundations of classical physics - and in *Ulysses* we encounter Bloom musing about these same concepts.

The difficulty with Newton's assumptions began to be apparent when physicists such as Michelson and Morley tried to prove absolute space existed:

> Nineteenth century scientists suggested that a luminiferous ether pervaded the universe and was the medium that transported light. But if such an ether existed it would surely mean that absolute space existed. Michelson and Morley wanted to establish the existence of the ether by determining the passage of the earth through it (Shallis 34-5).

However, they failed to find evidence of Newton's absolute space and the ether theory had to be abandoned as the "experiment demonstrated that the ether did not exist" (35). Bloom cites the ether theory word for word at *U* 17.262-3.

Einstein saw that he was unable to use the ether theory to determine any place of absolute rest from which all other velocities could be observed. He decided to assume that the observers are themselves at rest and all other motion is relative to them: the

relative motion postulate[6] - which Bloom illustrates perfectly at *U* 17.2305-10. The postulate was a huge simplification, but it came with a problem: "... the acceptance of the relativity principle must necessarily lead to a revision of our ordinary concepts of space and time" (Møller 5). Newton's theory of absolute, universal, linear time had to be abandoned for Einstein's relativity theory, which was based around an absolute speed of light, *c*, as defined by James Clerk Maxwell's equations for electromagnetic propagation.

Einstein stressed "the fact that it is impermissible to speak of absolute time, simply because absolute time cannot be observed; that only clock readings ... are relevant to the determination of time" (cited by Brian 156). In *Ulysses* clock readings occur everywhere; they are one of Bloom's major preoccupations. Further, Einstein gave a mathematical definition of a clock in a form physicists could use when he wrote in 1905: "We establish *by definition* that the 'time' required by light to travel from A to B equals the 'time' it requires to travel from B to A" ("On the Electrodynamics of Moving Bodies" 40). March writes, "The speed of light becomes no more than a conversion factor between units of space and time" (126). Bloom comes very close to quoting Einstein's 1905 definition at *U* 13.987-89.

Einstein also showed that space (i.e. distance) and time are relative to the velocity of light. As velocities increase towards *c*, "the concept of length has lost its absolute meaning" (Møller 46) and " the rate of clocks and therefore also the unit of time should ... depend on the state of motion of the inertial system" (30). Yet, Einstein had even stranger things to show us about the ultimate nature of reality, notably the "equivalence of energy and mass" (77); $E = mc^2$.

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[6] The relative motion postulate (also known as the relativity principle) was introduced by Einstein in 1905 with three almost incomprehensible sentences, in which he argued that the laws of physics were valid regardless of states of absolute rest, or relative motion – contradicting Newtonian mechanics:

> The phenomena of electrodynamics as well as of mechanics possess no properties corresponding to the idea of absolute rest. They suggest rather that, as has already been shown to the first order of small qualities, the same laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics holds good. We will raise this conjecture (the purport of which will hereafter be called the "Principle of Relativity") to the status of postulate ("On the Electrodynamics of Moving Bodies" 37-8).

Obviously, there are fundamental differences between Einstein and Newton. In the relativity theory, the mathematically definable quality of energy, *E*, replaces Newton's faulty concept of force, *F*. Møller writes, "In relativistic mechanics the concept of force has no longer any absolute meaning as it has in Newtonian mechanics" (73). After observing the fall of an apple in his Woolsthorpe orchard, and realising that the same force which caused the apple to fall also caused the moon to move in its orbit, Newton formulated the force of gravity, which he named "the universal law of gravitation" (Gribbin *Companion* 289-93). However, Newton postulated that this force of gravity acted instantaneously and continuously whereas Einstein proved that nothing could travel faster than the absolute speed of light, so Newton's theories of gravitation were incorrect. As March says, "space-time itself is curved, we can explain everything we know about gravity without ever having to mention a force" (140-1). Likewise, in a direct dismissal of Newton's gravity, March adds, "People who live in round worlds but insist they are flat are bound to invent forces like gravity" (140). In *Ulysses*, Bloom appears to know this when he gives a comic version of Newton's force of gravitational attraction in *U* 17.2162-8. In addition, since "the principle of relativity requires that all signals are propagated with a velocity smaller than or equal to *c*, it is impossible to maintain the Newtonian idea of forces acting instantaneously over finite distances of space" (Møller 163). Bloom demonstrates that he knows this relativity principle at *U* 17.1137-45. Likewise, Newton assumed that the geometry of space and time was flat - Euclidean geometry. Yet, Einstein's maths showed that the geometry of space and time is curved - "non-Euclidean geometry" (226). In *Ulysses*, Bloom performs gravitational experiments and interrogates Newton's notions of gravity at *U* 5.39-52, 8.44-80, 15.3367-90.

Einstein's general theory of relativity (1916) is also alluded to in *Ulysses*. Existing in ten horrendous equations describing gravitational fields, the general theory entirely abolished Newton's force of gravity acting as an instantaneous force of attraction. Einstein's theory states, "On account of the equivalence of mass and energy, we must assume that any energy distribution, thus for instance an electromagnetic field, will create a gravitational field" (Møller 310). Einstein's maths shows how gravitational mass or energy curves space and time, creating the field - the "Riemann-Christoffel" curvature (*ibid*). This curving of space or "warping of time" is a dominant feature of "Circe's" dance of the hours (*U* 15.4005-154).

Einstein's insight into the curvature of space and time resulted from an epiphany concerning the principle of equivalence. He postulated that gravity and acceleration are equivalent and that "gravitational fields have only a relative existence" (*Morgan Manuscript*[7]). Einstein "was astonished by the sudden idea that a man falling freely - and accelerating - would not feel his own weight" and that masses in free fall would move in an orbit, "their paths determined by the curved structure of space" (Brian 72). These ideas go under the name of a *Gedankenexperiment*. In *Ulysses*, they are alluded to at *U* 3.10-28, 8.52, 15.1539-55, 15.3374-76, 17.83-93.

The hardest of Einstein's concepts to understand - also alluded to in *Ulysses* - is "The Gravitational Red Shift of Light and Clocks" (Will 42). Kitty Ferguson writes:

> Time dilation isn't easy to understand. It helps if you know that time dilation and red shift are two faces of the same coin ... acceleration and gravity can have almost identical effects on things. Both ... can stretch electromagnetic waves.... Since whatever we perceive about events at a distance comes to us by some sort of waves, red shifting of those waves means we perceive those events at a slowed down rate: in other words we have time dilation (60).

In other words the slowing frequency of red shifted light waves effected by gravity or acceleration amounts to the slowing of time itself. To put it another way, the warping or non-linear curving of time is evidenced by the longer frequencies of red shifted light waves. In 1911 Einstein suggested "that the effect be looked for during a total solar eclipse" (Will 68). Then, on 29 May 1919, Sir Arthur Stanley Eddington observed a solar eclipse and "when the photographs were compared with others ... Einstein's prediction was borne out" (March 147). Interestingly, we find Bloom alluding to Einstein and Eddington and thinking about an eclipse at *U* 8.523-611.

Einstein's general theory of relativity brought about a revolution in cosmology. Newton's notions of the clockwork universe - the cosmos acting as a gigantic piece of clockwork governed by the three laws of motion and the force of gravity - had to be abandoned. In *Ulysses* we see "Wandering Rocks" abandoning the old Newtonian clockwork concept, while in "Ithaca" the new cosmology is a dominant feature of

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[7] *"Grundgedanken und Methoden der Relativitätstheorie in ihrer Entwicklung dargestellt"* in *Morgan ms.*

Bloom's musings. Significantly, Bloomsday closes on a note of relativity: *U* 17.3203-10. The enlarged full stop signals not only the final state of rest for Bloom, but also the end of the old Newtonian notions of time and space, to be succeeded by a new period of Einsteinian relativity, first in "Penelope", then in *Finnegans Wake*. However, Bloom is never conscious of the significance of his musings; he is denied the sort of epiphany that prompted Einstein's theories.

JOYCE'S TIMEBALL EPIPHANY

Hugh Kenner draws attention to the "aesthetic of delay" (72) in Joyce's work, whereby the meanings of certain events or situations are held in abeyance until revisited in a later chapter, providing the reader with a swift and sure moment of illumination: an epiphany. In a particularly instructive passage, Kenner points out that this "aesthetic of delay" not only works within a single text, but also traverses the boundaries between Joyce's novels. Sometimes, an obscure detail in an early text (for example *Portrait*) is clarified by a later text (for example *Ulysses*). At other times, the reverse occurs; obscurity is clarified by recourse to an earlier work. The significance of Bloom's musings in front of the Ballast Office clock is intensified by our awareness of the fact that, in *Stephen Hero,* Stephen defined an epiphany with reference to the timeball:

> He told Cranly that the clock of the Ballast Office was capable of an epiphany. Cranly questioned the inscrutable dial of the Ballast Office with his no less inscrutable countenance.
>
> - Yes, said Stephen. I will pass it time after time, allude to it, refer to it, catch a glimpse of it. It is only an item in the catalogue of Dublin's street furniture. Then all at once I see it and I know at once what it is: epiphany.
>
> - What?
>
> - Imagine my glimpses at that clock as the gropings of a spiritual eye which seeks to adjust its vision to an exact focus. The moment the focus is reached the object is epiphanised. It is just in this epiphany that I find the third, the supreme quality of beauty.
>
> - Yes? said Cranly absently (211).

This passage is a classic account of Joyce's aesthetic concept of "epiphany": the essence of some object or event captured and crystallised, as it were, outside time. Why Joyce should choose a chronometer - and not just any chronometer, but the most accurate time device in existence in the early twentieth century: the Ballast Office clock and its associated timeball - as the occasion for this definition, has evidently never been explained. Surely, Joyce's point is to use the clock as a foil for Stephen's momentary escape from the tyranny of time, as he experiences his epiphany.

Stephen could be speaking about Bloom when he announces that he intends to "Pass it time after time, allude to it, refer to it, catch a glimpse of it" and "see it" (*SH* 211). For,

in *Ulysses*, Bloom passes the Ballast Office clock (*U* 8.571), refers to it (*U* 17.1677-78), almost catches a glimpse of it (*U* 8.114) and yet fails to see it (*U* 8.109). The "aesthetic of delay" functions to stress Bloom's kinship with Cranly rather than with Stephen; Stephen's epiphany is denied to both.

Stephen says to Cranly, "Imagine my glimpses at that clock as the gropings of a spiritual eye which seeks to adjust its vision to an exact focus. The moment the focus is reached the object is epiphanised". Bloom, on the other hand, despite his good vision - "clearly I can see today ... Moisture about gives long sight..." (*U* 5.112) - fails to achieve epiphany. He even fails to register properly to the sort of timepiece which provided Stephen with the foil for his epiphany:

> Must get those old glasses of mine set right. Goerz lenses six guineas. Germans making their way everywhere ... There's a little watch up there on the roof of the bank to test those glasses by.
>
> His lids came down on the lower rims of his irides. Can't see it. If you imagine it's there you can almost see it. Can't see it[8] (*U* 8.554-63).

Kenner comments on the relatedness of these *Stephen Hero* and *Ulysses* passages:

> This effort to perceive a watch that perhaps isn't there - Bloom groping to adjust not his spiritual but his corporeal eye to a correct focus - corresponds in Joyce's intricate bookkeeping to the earlier failure to so much as glance up at the dial of the blatant Ballast Office clock ...; that clock's exemplary status in a theory of perception is accessible to us only because some pages Joyce discarded from the Ur-*Portrait* chanced not to be lost (74).

So, why does Joyce invent a "little watch"[9] simply so that Bloom can fail to see it? Why all the references to the clock and timeball in *Ulysses*? What is this time epiphany, which Stephen refers to, that neither Cranly nor Bloom understands?

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[8] I will revisit this passage later to describe the time epiphany Bloom fails to see.

[9] The "little watch" isn't the Ballast Office clock. In fact, it probably wasn't there at all according to Margaret McBride: "Bloom begins to conjure up clocks where none exist" (29). McBride comments further that, "Dublin residents interviewed in 1969 could not recall having heard of the 'little watch' and doubted if it had ever been there.... that Bloom's ability to 'almost see it' is indeed [in] his imagination" (38).

Evidently Bloom fails to register properly to these various chronometers because - obsessed by Molly's appointment with Boylan at 4pm - he is so preoccupied with the linear progress of time. In "Calypso", for example, he thinks of writing a short story about Molly, which in its linear-time organisation mimics the ostensible progress of *Ulysses* itself:

> Might manage a sketch. By Mr and Mrs L. M. Bloom. Invent a story for some proverb. Which? Time.... Timing her. 9.15. Did Roberts pay you yet? 9.20. What had Gretta Conroy on? 9.23. What possessed me to buy this comb? 9.24. I'm swelled after that cabbage.... Morning after the bazaar dance when May's band played Ponchielli's dance of the hours. Explain that: morning hours, noon, then evening coming on, then night hours. Washing her teeth.... Is that Boylan well off? He has money....
>
> Evening hours, girls in grey gauze. Night hours then: black with daggers and eyemasks.... Day: then the night.
>
> He tore away half the prize story sharply and wiped himself with it. Then he girded up his trousers, braced and buttoned himself....
>
> A creak and a dark whirr in the air high up. The bells of George's church. They tolled the hour: loud dark iron.
>
> *Heigho! Heigho!*
> *Heigho! Heigho!*
> *Heigho! Heigho!*
>
> Quarter to (*U* 4.518-49).

Bloom's short story seems to be little more than a useless chronological catalogue of Molly's blabbering. He is preoccupied with linear, chronometrical time, with cataloguing time itself. Similarly, Joyce concludes Bloom's story with "The bells of George's church" tolling the hour - highlighting the exact moment in time ("Quarter to" ten) when he finishes on the "jakes" and pulls his pants up. We see a concordance between Bloom's plan to write a story obsessionally timing Molly's activities and Joyce's obsessional catalogue of Bloom's toilet activities. In both cases, time tells the story.

Yet, if linear time really does tell the story in *Ulysses*, there is a puzzling allusion in this passage that we barely register to until much later in the text: "Ponchielli's dance of the hours". This dance is finally enacted at the climax of the climactic episode ("Circe"): the moment when Stephen confronts his dead mother - arguably the one true epiphany in *Ulysses*. The hours appear "spinning", "twirling", "turning", "swirling" and "twining" (*U* 15.4034, 4056, 4061, 4092, 4099), and, as Blamires writes: "Stephen is swept into a

delirious series of gyrations..."(182). This depiction of time is anything but "linear" or "straight". It is quite at odds with both Bloom's story and Joyce's text at the end of "Calypso", where time marches in single file like "Wisdom Hely's" advertising sandwich men (*U* 8.123-28). The "Calypso" passage leads us to anticipate a linear plot development with a beginning, middle, and an end. In short, we would expect the text to treat time as Newton conceived it when he wrote "in the *Scholium* in *Principia,* that absolute true and mathematical time flows equably from past to future without regard to anything external" (cited by Nerlich 225). However, Ponchielli's dancing, turning, gyrating hours bring about a transformation in the depiction of time. When May Dedalus and Rudy Bloom rise from the dead and appear to Bloom and Stephen at the conclusion of the dance, they reenact Homer's (127-37) description of the shades from the past returning to talk to Odysseus. They bring the past back to life as well - and with Rudy's return as "*a fairy boy of eleven*" (*U* 15.4957) - the "dance of the hours" also enacts potential but unrealised futures. Rudy even "*reads from right to left*" (*U* 15.4959). That is, he either reads Hebrew, or processes time, backwards. Therefore, "Circe" in general, and "Ponchielli's dance of the hours" in particular, behaves in a way more akin to Einstein's conception of time. Einstein wrote: "Time is not all that it seems, it does not flow in only one direction and the past may coexist simultaneously with the present and the future" (cited by Drosnin 31). Again, "For us believing physicists, the distinction between past, present and future is only an illusion, however persistent" (cited by Hoffmann 223). As we examine passages from *Ulysses* carefully, we will see just how unstable time often becomes and how it increasingly abandons Newton's linearity for Einstein's curvature. But Bloom, even when he is engulfed by non-linear manifestations of time, is never fully aware of the fact. He cannot step outside linear time, as Stephen can - or could in *Stephen Hero* - during his moments of epiphany.

Kumar complains about Joyce's "perverse naturalism in the attempt to reproduce the geographical details of Dublin as well as the precision of the public, chronometric time of 16 June 1904" (4). No other novel comes close to *Ulysses* in its insistence on grounding itself in linear, "public, chronometric time". Every chapter appears to provide some reference to its hour of enactment. So, for example, in "Circe" we read: "*Midnight chimes from distant steeples*" (*U* 15.1362); and in "Penelope" Molly observes: "... wait theres Georges church bells wait 3 quarters the hour 1 wait 2 oclock" [*sic*] (*U* 18.1231-

32); while in "Oxen of the Sun", on the way to the pub someone remarks: "Keep a watch on the clock. Chucking out time ..." and the reply is: "... got my timepiece. Ten to", then later the publican cries: "Closingtime, gents ... Time all. There's eleven of them. Get ye gone." (*U* 14.1452-62). Similarly, at the conclusion of "Nausicaa", Gerty MacDowell imagines the nine cuckoos of the cuckoo clock as it strikes 9pm:

> *Cuckoo*
> *Cuckoo*
> *Cuckoo*
>
> The clock on the mantelpiece ...
>
> *Cuckoo*
> *Cuckoo*
> *Cuckoo*
>
> a little canarybird came out of its little house ...
>
> *Cuckoo*
> *Cuckoo*
> *Cuckoo* (*U* 13.1289-1306) [10].

Nowhere is temporal-spatial location specified with greater navigational precision, however, than with the references to the Ballast Office clock and timeball. Kenner writes:

> The Ballast Office clock, an object of no special interest, was perhaps the most looked-at object in all Dublin.... Seamen could set their chronometers by the drop of its time-ball, and in a city of stopped and casual clocks ... the authority of its dial reassured countless glancing eyes daily (72).

Actually, Joyce uses the Ballast Office clock and its associated timeball to make various subtle points about time. When Bloom encounters the clock in "Lestrygonians" it reminds him of the onward march of time, but only after he thinks of the alarming prospect that Boylan might give Molly the clap:

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[10] Of course the nine cries of the cuckoo are not related only to public chronometrical time; the cuckoo is also alluding to Bloom as a cuckold. The moment of adultery is already past and he has done nothing to intervene; the cuckoo clock both chimes the hour and jeers at his failure to act in time. This is typical of Joyce's use of time both to refer to something immediate and to allude to some other event, which happens elsewhere and off stage.

> If he....?
> O!
> Eh?
> No ..... No.
> No, no. I don't believe it. He wouldn't surely?
> No, No.
> Mr Bloom moved forward, raising his troubled eyes. Think no more about that. After one. Timeball on the ballastoffice[11] is down (*U* 8.102-9).

Later Bloom thinks, "At four, she said. Time ever passing. Clockhands turning. On" (*U* 11:188). For the rest of the day, the clock is associated with the onward flow of time and Molly's adultery.

To suppress this frightening train of thought, Bloom shifts his attention from the linear progression of time to more abstract considerations, akin not so much to Stephen's epiphany as to Einstein's themes but decked out in the more traditional language of Sir Robert Ball:

> Dunsink time. Fascinating little book that is of sir Robert Ball's[12]. Parallax. I never exactly understood. There's a priest. Could ask him. Par it's Greek: parallel, parallax. Met him pike hoses she called it till I told her about the transmigration. O rocks!
> Mr Bloom smiled O rocks at two windows of the ballastoffice. She's right after all. Only big words for ordinary things on account of the sound (*U* 8.109-15).

At one level, Bloom's response, "Think no more about that" is an example of the Freudian defense-mechanism of suppression[13]. In 1915, Freud postulated that "*the essence of repression lies simply in the function of rejecting and keeping something out of consciousness*" [his italics] (101). We see this process happening to Bloom here in the timeball reference; to suppress the troubling thoughts that he doesn't want to imagine, Bloom thinks about theoretical aspects of time. But the thoughts, interrupted by the timeball, are also intrinsically interesting. Bloom's interior monologue here features a

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[11] Gabler's 1986 edition of *Ulysses* reads "ballastoffice", however other editions read "Ballast Office".
[12] Gabler's 1986 edition of *Ulysses* does not capitalise the "sir" of "sir Robert Ball" here, but does elsewhere (e.g. *U* 17.1373), however, some other editions may read "Sir Robert Ball". In accordance with MLA requirements, when not directly quoting I will capitalise the "S" on sir. Likewise for all subsequent non-standard grammar – e.g. "Mr[.] Deasy", "professor Joly", "Lt[.]William Humble earl of Dudley" *et al.* However, in consistency with most of the physics texts I quote, which generally avoid capitalisation, I do not capitalise the special and general theories of relativity, the postulates, or the Newtonian laws, *etc.*
[13] Suppression is the conscious and intended variation of subconscious unintentional repression.

pattern of thought that occurs repeatedly throughout *Ulysses*. His thoughts move, almost like clockwork, from concerns about Boylan and Molly to concerns about time, gravity, Newtonian and Einsteinian physics, and cosmology. This characteristic shift from thoughts of Molly's adultery to abstract considerations of time and space is beginning to establish itself in this timeball passage from "Lestrygonians". In this case, as we have seen, he ends up pondering the astronomical concept of "parallax". In *The Arrow of Time*, Roger Highfield explains the term: "As the Earth moves in its orbit around the Sun, the apparent position in the sky of a star, as seen from the Earth, varies. Using trigonometry, the amount of this variation, called parallax (measured in seconds of arc) gives the distance to the star relative to the Earth's orbit" (321). This measurement of astronomical distances was also spelled out in that "Fascinating little book ... of sir Robert Balls" (*U* 8.110), *The Story of the Heavens*– a book which Bloom has in his library (*U* 17.1373).

However, Sir Robert Ball's method of reckoning distances in space by parallax was soon rendered obsolete. One year after 16 June 1904 and Bloom's musings on parallax, Einstein promulgated the special theory of relativity. He wrote in 1905: "We introduce a postulate ... namely, that light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body" ("On the Electrodynamics of Moving Bodies" 38). Ever since the special theory of relativity established the absolute velocity of light as a theoretical axiom, light rather than parallax has become the scientific means of measuring space and time. Nowadays astronomical and interstellar distances are calculated in light years. Here, as always, Bloom just misses the opportunity for a true (Einsteinian) epiphany concerning the nature of time - just as he earlier declined an epiphany of a different kind concerning Molly's relations with Boylan.

Highfield explains the relationships between the old means of measuring space and time and the new:

> The word parsec derives from parallax and seconds.... A parallax of one second corresponds to a distance of one parsec, by definition, which is 3.26 light years (321). It is easiest to think of spacetime as if it were space alone and use the speed of light as a measuring stick (remember that the speed of

> light is absolute). An interval of time can be converted into its spatial length simply by measuring it in terms of the distance traveled by light during that interval (86).

Ironically Joyce, in "Ithaca", has Bloom on 17 June 1904 already toying with the concept of light years as he talks to Stephen "of Sirius (alpha in Canis Maior [*sic*]) 10 lightyears (57,000,000,000,000 miles) distant and in volume 900 times the dimension of our planet ..." (*U* 17.1046-8).

Interestingly, when Highfield goes on to give a few representative examples of Einstein's method, one involves "Sirius" which "is 2.7 parsecs away" (86) - that is approximately 8.802 light years, astoundingly close to Bloom's "10 lightyears". So, although Bloom "never exactly understood ...sir Robert Ball's little book" (*U* 8.110), by the end of *Ulysses* he has surpassed Ball's understanding of cosmology. Bloom has the potential to become an Einsteinian genius, but he doesn't know it; just like Cranly in *Stephen Hero*, he is evidently incapable of epiphany.

NEWTONIAN MECHANICS, TIME, PREDESTINATION AND *ULYSSES*

Newtonian physics held absolute ascendancy in the Western world for nearly two hundred years. It ushered in the age of reason; it described the cosmos; it defined theoretical physics; it reinforced Calvinistic and related deterministic doctrine in the Church. It also governed politics; national security became, in Newtonian terms, simply a matter of producing a large enough force to overcome an enemy's opposing force. In the Citizen's dialogue with Bloom in "Cyclops", national defense is predicated on Newtonian force – action and reaction:

> - But, says Bloom, isn't discipline the same everywhere. I mean wouldn't it be the same here if you put force against force?....
> - We'll put force against force, says the citizen. We have our greater Ireland beyond the sea. They were driven out of house and home.... But they will come again and with a vengeance (*U* 12.1360-73).

The pitting of force against force shows the downside of the so-called Age of Reason that arose from Newtonian mechanics. The peaceful simplicity of time and motion which is ostensibly portrayed in "Wandering Rocks" is little more than a veneer covering the social forces which were destined to tear the idyllic peace of Dublin apart. When Joyce published *Ulysses* on his fortieth birthday in 1922, the Dublin of "Wandering Rocks" had already ceased to exist; the Anglo-Irish boys Stephen taught in "Nestor" lay in Flanders' fields and Dublin had been burned in the Easter Uprising - the consequence of the Citizen's one-eyed nationalism. Such were the results of Newtonian "force against force" actioned on a gigantic international scale.

Newtonian mechanics is built on assumptions of the absolute qualities of force, inertia, mass, time, and gravitation. At the heart of this system are three concepts concerning the nature of time itself. Newton believed that the universe functioned over time as some gigantic piece of clockwork governed by his three laws of motion and the law of gravitation. He also believed that time flowed "from past to future" at the same rate throughout the universe - which he called "absolute time" (Nerlich 225). Further, Newton, a Puritan, believed that the predictability of physical phenomena led naturally to a belief in Calvinistic predestination.

The physicist Spielberg explains the clockwork universe thus:

> Newton's great synthesis of the laws of motion and the universal law of gravitation to explain all kinds of motion had a great philosophical and emotional impact on the scientists of the time. His work created an image of a great clockwork-like universe.... The Mechanical Universe.... If one takes this realization to its apparent logical conclusion, it implies that the future motions of all the objects of the universe could be predicted if we could only determine what they are right now.... Whatever the positions and velocities are now completely determines what they will be in the future. It does not matter that we cannot carry out the calculations of the future of the entire universe; it is still completely determined.... Newton's laws indicated that the motions and interactions of all the material bodies of the universe obey a few certain, relatively simple rules.... Newton's laws indicate a universe evolving in time, according to his laws, in a completely predetermined fashion. The universe is like giant, elaborate clockwork, operating in a prescribed way. Many philosophers cited Newton's work as proof of predestination (103).

Spielberg further explains what Newtonian mechanics means:

> Newton's work represents one of the greatest contributions made by an individual to human understanding of the physical universe. It is difficult to over-estimate the impact of his work on Western thought.... He developed a picture of the universe as a subtle, elaborate clockwork, working according to well-defined rules (88).

The central chapter of *Ulysses*, "Wandering Rocks", displays all the symptoms of the Newtonian mechanical universe. It is choreographed like clockwork. There are numerous references to time and velocity throughout the chapter. Even characterisation appears mechanical and predestined. Clockwork apparatus is in abundance, and the *Linati Schema* identifies the "art" which is displayed in the chapter as "mechanics" (Gilbert 41). Frank Budgen observes of "Wandering Rocks": "the action goes forward at clockspeed" (133).

Joyce begins with a reference to time: "The superior, the very reverend John Conmee S.J. reset his smooth watch in his interior pocket as he came down the presbytery steps. Five to three. Just nice time to walk to Artane" (*U* 10. 1-3). Joyce then proceeds to allude to clockwork apparatus throughout the chapter, reinforcing the Newtonian view of the universe as, "like a giant, elaborate clockwork operating in a

prescribed way" (Spielberg 103). In the fifth scene of "Wandering Rocks", for example, we read: "Blazes Boylan ... turned suddenly, ... drew a gold watch from his fob and held it at chain's length" (*U* 10.307-13). In the sixth scene, Boylan's secretary, arranging Boylan's itinerary by phone, pays elaborate attention to time: "- Hello. Yes, sir. No, sir. Yes, sir. I'll ring them up after five.... All right, sir. Then I can go after six if you're not back. A quarter after. Yes, sir" (*U* 10.389-91). Then, in the eleventh scene we are told: "From the sundial towards James's gate walked Mr Kernan" (*U* 10.718). Note the unusual word order, which actually emphasises the time reference by putting it first.

In the twelfth scene we get a verbal pun on time: "Stephen Dedalus watched through the webbed window the lapidary's fingers prove a timedulled chain" (*U* 10.800-1). We see a further reference to time in this scene, when, as Stephen walks about the city he overhears "Yes, quite true. Very large and wonderful and keeps famous time." (*U* 10.828). This contributes nothing to plot development; it simply highlights the clockwork machinery. Then, in the thirteenth scene Father Cowley remarks "All I want is a little time" (*U* 10.894). The fourteenth scene contains another pun on the passing of time: "...a dapper little man ... walked uncertainly, with hasty steps past Micky Anderson's watches" (*U* 10.987-8).

In the fifteenth scene we see a more complex time reference, with allusions to Joyce, when Buck Mulligan mocks Stephen's ambitious plans for authorship: "- Ten years, he said, chewing and laughing. He is going to write something in ten years" (*U* 10.1089-90). Then, in the closing nineteenth scene there are three distinct gags relating to time, each of which illustrates a particular individual's character, providing a swift and sure moment of epiphany concerning their respective psychological make-ups. One can sense a man of utmost punctuality in the description of the Lt. Governor: "The Right Honourable William Humble, earl of Dudley, G.C.V.O., passed Micky Anderson's alltimesticking[14]watches" (*U* 10.1213-4). Likewise, time has endowed "John Henry Menton" with wealth and ease as he filled "the doorway of Commercial Buildings, stared

[14] The portmanteau word "alltimesticking" could be broken down as "all times ticking", or perhaps, "all time sticking". Both interpretations emphasise reliability and punctuality and both apply to the watches and, by association, to the Governor.

from winebig oyster eyes, holding a fat gold hunter watch not looked at in his fat left hand not feeling it" (*U* 10.1229-31). Similarly, Blazes Boylan is time's playboy: "By the provost's wall came jauntily Blazes Boylan, stepping in tan shoes and socks with skyblue clocks" (*U* 10.1240-42). There is a pun here on the word "clock", which also refers to a silk pattern on a stocking or sock. So we can see that as the chapter progresses it accumulates more and more mechanical and clockwork machinery. On the surface, "Wandering Rocks" functions as a time-and-motion study.

James Fairhall asks "What does it mean when a work of art, or part of one, is constructed as a time-and-motion study?"(211). As a New Historicist, Fairhall convincingly interprets the meaning of the chapter within the context of the period in which *Ulysses* was written. He asserts:

> The Arranger's measuring of human movements through time and space in "Wandering Rocks" suggests a basic tool - the time-and-motion study of procedures performed by assembly-line workers - for measuring productivity in a factory. And it suggests the dependence of most technologies on finely measured temporal-spatial relationships.... In its very form, then, "Wandering Rocks" represents a response to the acceleration of history in Joyce's era and its attendant danger for the artist of pathetic anachronism. The "content" of the form is its reflection through the Arranger of a distinctively modern consciousness or way of looking at the world, one that breaks reality down into space-time relationships which are minutely realistic yet are also abstract in their removal from the individual's everyday felt experience. In other words, the chapter's radical form and its suprapersonal mechanistic consciousness at once reflect and attempt to contain history. Like other manifestations of the Arranger, they are aimed at matching the strangeness and newness of the present with their own strange new forms (211).

Fairhall is correct when he argues that "Wandering Rocks" seems to be constructed very mechanically as a gigantic "time-and-motion study" and that it "breaks reality down into space-time relationships". Fairhall emphasises "Fordism"; I argue, on the other hand, that the wider thrust of the chapter's focus is the self-conscious disclosure of Newtonian mechanics, which insists that the universe exists as some kind of enormous clockwork apparatus, where everything can be predicted using Newton's three laws of motion and the law of gravity, providing time and velocities are known.

Budgen informs us that Joyce wrote "Wandering Rocks" with particular chronometrical care:

> Joyce wrote *Wandering Rocks* [*sic*] with a map of Dublin before him on which were traced in red ink the paths of the Earl of Dudley and Father Conmee. He calculated to a minute the time necessary for his characters to cover a certain distance of the city (124-5).

Moreover,

> Clive Hart, who retraced all the character's routes with watch in hand, confirms that they (and even the throwaway floating down the Liffey) could have realistically followed their itineraries in the time allotted (Fairhall 211).

Budgen draws an explicit association between "Wandering Rocks" and Newtonian physics:

> Apart from Father Conmee's journey to Artane and the official viceregal drive to Sandymount, there are eighteen pictures in the episode, each one featuring the activities of one or several of the characters. According to their directions and velocities their position at any time is noted, for they are all regarded in a twofold sense. They are human souls bound together by psychological ties ... and they are also bodies, isolated masses of matter moving through space (126).

Budgen goes on to observe:

> In *Wandering Rocks* [*sic*] the action goes forward at clockspeed (133). As Bloom says, 'Time is the time the movement takes'.... With the exception of Stephen, who is concerned with time as the medium in which his destiny unfolds and who hates past time because it would bind him with present duties, all the characters in *Ulysses* have just that social time sense that is part of the general social mentality of the period, and no more.... It is a purely technical thing, born of mechanical development (131).

Lewis makes much the same point about *Ulysses*, though he stresses the connections with Victorian naturalism rather than with Newton:

> The nineteenth-century naturalism of that obsessional, fanatical order is what you find on the one hand in *Ulysses*.... It is the sardonic catafalque of the victorian [*sic*] world.... The inner meaning of the *time-philosophy*, from whatever standpoint you approach it, and however much you paste it over with

> confusing advertisements of 'life,' of 'organism,' is the doctrine of a mechanistic universe; periodic; timeless, or nothing but 'time,' whichever you prefer; and, above all, essentially *dead*.... The theoretic truth that the time-philosophy affirms is a mechanistic one. It is the conception of an aged intelligence, grown mechanical and living upon routine and memory, essentially; its tendency, in its characteristic working, is infallibly to transform the living into the machine (92-4).

Note the similarities between these critics' statements and the particle physicist March's summary of Newtonian mechanics and its reliance on absolute chronometrical time and predictability:

> In Newton's physics, motion is governed by perfectly deterministic laws. Early in the nineteenth century, the mathematical physicist Pierre-Simon de Laplace speculated that if one could only observe at some instant all of the atoms in the universe and record their motions, both the future and the past would hold no secrets. Put another way, all of history was determined, down to the last detail, when the universe was set in motion. The rise and fall of empires, the passion of every forgotten love affair, represent no more than the inevitable workings of the laws of physics[15]; the universe marches to its unalterable destiny like one gigantic clockwork (76).

Clearly, the central organizing principle of "Wandering Rocks" is Newtonian mechanics. However, I also contend that Joyce sets up Newtonian mechanics for interrogation and an eventual fall in this chapter. "Wandering Rocks" is the book's central chapter, and here Joyce kisses goodbye to linear discourse forever with one last salute, and then exits from the Newtonian stage: "His Excellency acknowledged punctually salutes from rare male walkers... the salute of Almidano Artifoni's sturdy trousers swallowed by a closing door" (*U* 10.1278-82). "Wandering Rocks" is the crucial transition from linear narrative to increasingly circular and cyclical patterns, whose dependence on Vico has often been noted, but whose debt to Einstein is as yet unremarked.

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[15] Notice how Newtonian mechanics asserts, "the passion of every forgotten love affair represent no more than the inevitable workings of the laws of physics." Presently we will see Bloom's belief in this deterministic philosophy (as an explanation for Molly's adultery) come under a sustained post-Newtonian attack.

In "Wandering Rocks" there are, in fact, important departures from Newtonian mechanics. Clive Hart identifies that one such departure involves the disruption of the seamless flow of Newtonian time by means of "gaps and cracks"[16]. Hart explains:

> *Ulysses* seems at times to present a continuous flow, chronologically in parallel with the time flow of the represented world of Bloomsday. At other times it seems to burst out of that time sequence into others - earlier, deeper, more remote - and even to interpolate things by cutting the continuity to insert extra time. From the start we are made unsure of the relationship of word flow to world flow (*JJQ* 427).

To disrupt the flow of time in this way is to contradict Newton:

> Newton said, in the *Scholium* in *Principia*, that 'absolute true and mathematical time ... flows equably from past to future without regard to anything external'. It is the idea of flow which Newton evidently felt picked out the essential feature which makes time different from space (Nerlich 225).

On close examination, the Newtonian flow of time is indeed disrupted by breaks in chronological sequence. Some breaks are explicable as flashbacks in a particular character's consciousness. Father John Conmee's flashback to Clongowes is a good example:

> Father Conmee thought of that tyrannous incontinence, needed however for man's race on earth, and of the ways of God which were not our ways.
>
> Don John Conmee walked and moved in times of yore. He was humane and honoured there....
>
> Father Conmee, reading his office, watched a flock of muttoning clouds over Rathcoffey. His thinsocked ankles were tickled by the stubble of Clongowes field. He walked there, reading in the evening, and heard the cries of the boys' lines at their play, young cries in the quiet evening. He was their rector: his reign was mild.
>
> Father Conmee drew off his gloves and took his rededged breviary out....
>
> A flushed young man came from a gap of a hedge and after him came a young woman with wild nodding daisies in her hand. The young man raised his cap abruptly: the young woman abruptly bent and with slow care detached from her light skirt a clinging twig.

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[16] Hart observes, "At the centenary celebrations in Dublin, in 1982, some of us staged an amusing reenactment of 'Wandering Rocks'.... The reenactment was virtually invisible; inserted into the gaps and cracks of the real world, 'Wandering Rocks' was lost to view" (*JJQ* 436). Moreover, in an oblique reference to Newtonian time Hart comments: "Joyce is not much of a story teller. A continuous line through time is not something he handles with comfort. He is temperamentally much happier with spatial relationships outside time, with spatial form, in fact" (*JJQ* 434).

> Father Conmee blessed both gravely and turned a thin page of his breviary. *Sin* (*U* 10.171-204).

In this passage from the opening scene of "Wandering Rocks", Joyce signals his intention to incorporate flashbacks and even fantasies from "times of yore" into Conmee's free, indirect discourse. In the third paragraph quoted, Conmee is simply remembering his time at Clongowes (depicted in *Portrait*). The fact that Conmee's thought, "the ways of God which were not our ways" is a recapitulation of Orangeman Deasy's Calvinistic persuasions, "the ways of the creator are not our ways" (*U* 2.380), is harder to explain, but the phrase is reasonably commonplace, and so coincidence is possible.

All of this can be explained, then, in terms of mental flashback, and/or imagination. However, in the fourth scene of the chapter, a reiteration of Conmee's Clongowes flashback is inexplicable:

> - Did you put in the books? Boody asked....
> - They wouldn't give anything on them, she said.
> Father Conmee walked through Clongowes fields, his thinsocked ankles tickled by stubble.
> - Where did you try? Boody asked.
> - McGuiness's (*U* 10.260-7).

Who is doing the remembering? This scene involves Katey, Boody, and Maggy Dedalus, who do not know Conmee and have never been to Clongowes, so this can only be described as a textual flashback to Conmee's flashback - a textual memory of something that someone else remembered. Clearly, the text is no longer following Newtonian principles.

Likewise, in the seventh scene, we encounter another puzzling flashback to that earlier moment in the text when Conmee saw the young lover lifting a twig from her dress:

> - Yes, yes. Good afternoon, Mr Lambert. Very pleased to have met you.
> - Pleasure is mine, sir, Ned Lambert answered....
> He stood to read the card in his hand.

> - The reverend Hugh C. Love, Rathcoffey. Present address: Saint Michael's, Sallins. Nice young chap he is. He's writing a book about the Fitzgeralds he told me. He's well up in history, faith.
>
> The young woman with slow care detached from her light skirt a clinging twig.
>
> - I thought you were at a new gunpowder plot, J.J. O'Molloy said.
>
> Ned Lambert cracked his fingers in the air.
>
> - God! He cried (*U* 10.430-4).

The only connection between Lambert, O'Molloy, and Conmee's encounter with the young lovers near Rathcoffey is a business card of "Hugh C Love, Rathcoffey." Note the possible play on words here: Conmee was privy to seeing the lovers - "you see love" - and the business card reads "Hugh C Love". Yet, business cards don't have memories.

As if this doesn't disrupt temporal sequencing and Newtonian time-flow badly enough, in the fourth scene we encounter a spatial flash-away to the throwaway Elijah-is-coming paper ball which Bloom threw off O'Connell Bridge in a comic reenactment (to be discussed presently) of one of Newton's original gravity experiments:

> A skiff, a crumpled throwaway, Elijah is coming, rode lightly down the Liffey, under Loopline bridge, shooting the rapids where water chafed around the bridgepiers, sailing eastward past hulls and anchorchains, between the Customhouse old dock and George's quay (*U* 10.294-7).

The crumpled paper ball is now doing some very odd things temporal-spatially. As it sails along with the Liffey's flow, it alludes back in time to the original Homeric voyages of Odysseus as described in *The Odyssey*. It thus exists as a comical microcosmic enactment in the present of a past epic voyage. In the fifteenth scene it is still sailing "eastward":

> Elijah, skiff, light crumpled throwaway, sailed eastward by flanks of ships and trawlers, amid an archipelago of corks, beyond new Wapping street past Benson's ferry, and by the threemasted schooner *Rosevean* from Bridgwater with bricks (*U* 10.1096-9).

Yet in an intervening flash-away, the crumpled paper ball is sailing "westward", though still evidently flowing with the Liffey:

> North wall and sir John Rogerson's quay, with hulls and anchorchains, sailing westward, sailed by a skiff, a crumpled throwaway, rocked on the ferrywash, Elijah is coming (*U* 10 752-4).

It might be argued that the crumpled throwaway has momentarily been propelled backwards by "the ferrywash", yet the text obviously does not support this. On this point, John Hannay writes: "Curiously, this passage has managed to waylay several critics into thinking that the throwaway skiff has reversed its path and is sailing westward" (437). Blamires' comments are typical of these critics: "Flashback to Bloom's throwaway ... now floating westward in Sir John Rogerson's Quay" (94). Hart, who does so well in explaining gaps and cracks in "Wandering Rocks", comments about the throwaway:

> Joyce took the utmost pains over the physical details, even causing the throwaway, Elijah, to move at a speed which, according to the Dublin Port and Docks Board, is consistent with the probable rate of flow of the Liffey two and a half hours after high tide on that June day (Hart and Hayman 197).

So Hart does not notice the change of direction. Gifford does but does not explain why it happens (273-4).

Hannay, on the other hand, both notices the westward movement and explains it, attributing the change of direction to a change in the frame of reference used to look at what is happening. Newtonian absolutes are superseded by Einsteinian relativity:

> As in Einstein's relativity theory, there is no absolute motion: it is just as accurate to fix one's frame of reference on the throwaway and to consider the banks as moving past it as to fix one's frame of reference on the banks and to consider the throwaway as moving past them (437).

To argue that Bloom's throwaway displays a perfect example of Einstein's relative motion postulate throws two rather large spanners in the works of this time-and-motion study called "Wandering Rocks". The relative motion postulate was not proposed until 1905. In addition, the postulate[17] is a direct contradiction of Newton's theory of absolute space, which is at the heart of Newton's clockwork universe and which appears to

[17] I refer the reader back to my introduction on page 15 for Einstein's statements concerning the relative motion postulate, especially why it contradicts Newtonian mechanics – i.e. Newtonian mechanics are incompatible with Maxwell's electromagnetic equations - the postulate is quoted in the footnote.

underpin the chapter. According to the *Linati Schema* and most critics, "mechanics" is a central organizing principle of "Wandering Rocks". Nevertheless, the principle is honoured in the breach as well as the observance.

Time becomes non-linear. The Newtonian clockwork universe and its associated time-and-motion mechanics break down on closer examination. As Hart (despite the occasional oversight) shows, the synchronicity of absolute time - a central feature of Newton's theory - is broken by gaps, cracks, and flashbacks which occur independently of chronological sequence. Despite the numerous references to clocks and timepieces, an absolute universal and chronological time cannot be retrieved.

Similarly, motion becomes relative to the frame of reference. The textual flashaways are independent of a temporal-spatially locatable consciousness. In the example of Conmee's thoughts, it is impossible to identify who, or what, is remembering the Rathcoffey scene. Sudden jumps of reference frame are even stranger in the directions of the crumpled paper throwaway. More significantly, Hannay is correct in identifying Einstein's relative motion postulate as an explanation for the apparently changed direction.

However, Hannay does not go far enough in following up that crumpled paper ball. Bloom's references to the timeball, his thoughts on the physics of Sir Robert Ball, and the crumpled paper ball[18] are all interconnected, not in any haphazard fashion, but by a common underlying opposition to Newtonian mechanics and by wide-ranging allusions to Einstein's relativity theories.

It is one thing to thwart Newton's laws of motion with a relativistic reversal of an easterly direction to a westward one; quite another thing to reverse Newton's absolute time, as this strikes at the heart of Newtonian mechanics. To reverse absolute time is to destroy the laws of cause and effect, of action and reaction, on which Newtonian mechanics, the clockwork universe, and the predestined causality of Calvinism are based.

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[18] There could also be a "ball"/"Ball" pun here.

For clarity, we restate Newton's definition of absolute time: "Newton said, in the *Scholium* in *Principia*, that 'absolute true and mathematical time ... flows equably from past to future without regard to anything external'" (Nerlich 225). This definition formed the foundations of classical physics and highlighted three (apparently) self-evident aspects to time: time moves in only one direction "from past to future", time "flows" somehow like a river moving always downwards from a mountain to the sea,[19] time flows "equably" everywhere at the same speed throughout the universe. Despite Newton's assertion of "mathematical time", there was in fact no mathematics to support his theory. Then, when Einstein established the absolute velocity of light and his relative motion postulate, and proved them mathematically, it could be clearly seen that Newton was wrong. Thus, if absolute time is incorrect, then Newtonian mechanics, causality, and Calvinistic predetermination are unsustainable.

In "Nestor" the Protestant Orangeman Mr. Deasy expresses the Calvinistic doctrine of time and predestination: "- The ways of the Creator are not our ways, Mr Deasy said. All human history moves towards one great goal, the manifestation of God " (*U* 2.380-1). The central idea of Deasy's doctrine is that the whole of humanity is on a predestined time journey that is purely linear in nature. The journey begins at Creation and will end at the Last Judgement. In terms of plot development, characters - as well as whole nations - are moving towards the final states of either salvation or damnation.

However, Stephen's view of history is very unlike Deasy's. He sees Irish history, at least, as essentially tragic, a "nightmare", and God as something contingent rather than a necessary end:

> - History, Stephen said, is a nightmare from which I am trying to awake....
> Stephen jerked his thumb towards the window, saying:
> - That is God....
> What? Mr Deasy asked.
> - A shout in the street, Stephen answered... (*U* 2.377-86).

[19] Beginning with the "riverrun" opening sentence, this Newtonian concept is mocked continually in *FW*. The flow of the river Liffey, the flow of time, and Anna Livia Plurabelle all eventually merge into the sea, as all of human history merges into one non-linear, post-Newtonian time-cycle in the *Wake*.

To underscore this point, Joyce subjects Mr. Deasy's belief that all history moves towards one great goal - the manifestation of God - to a comic reversal in "Proteus":

> A woman and a man.... Their dog ambled about a bank of dwindling sand, trotting, sniffing on all sides. Looking for something lost in a past life.... The carcass lay on his path. He stopped, sniffed, stalked round it, brother, nosing closer, went round it, sniffling rapidly like a dog all over the dead dog's bedraggled fell. Dogskull, dogsniff, eyes on the ground, moves to one great goal. Ah, poor dogsbody! Here lies poor dogsbody's body (*U* 3.331-52).

Note that the passage highlights non-linear patterns of time. The references to "a past life" and the dog's circles suggest the recycling of time and metempsychotic reincarnation. Of more significance in this passage, however, is the fact that the Newtonian flow of time is reversed. Symbolically, this reversal is seen when the Divine name "God" is reversed as "dog", and the Christian symbol of the resurrected body of Christ becomes the decaying carcass of a dog (having earlier been "Christine"). And of course, there is a specific reversal of Deasy's Calvinistic belief that "All human history moves towards one great goal, the manifestation of God" (*U* 2.380-1); the Protean dog also "moves to one great goal", the body of its dead brother.

Opposition to Newton's absolute time is also evident with another time reversal in "Proteus". Stephen is strolling on the beach at Sandymount and considering all kinds of time theories. He wonders if time were to go backwards for two minutes, what it would look like for him to see a Paris post office concierge who had just been shotgunned to death. Unlike a traditional novel, which has either a happy ending (comedy) or a sad ending (tragedy), a story that reverses the flow of time will facilitate a reversal from a tragic to a comic ending. Stephen concludes the event would look like a movie running backwards; the man would reassemble from splattered bits, and the tragic ending would be reversed:

> *Encore deux minutes*. Look clock. Must get. *Fermé*. Hired dog! Shoot him to bloody bits with a bang shotgun, bits man splattered walls all brass buttons. Bits all khrrrrklak in place clack back. Not hurt? O, that's all right. Shake hands. See what I meant, see? O, that's all right. Shake a shake. O, that's all only all right (*U* 3.187-91).

A spectacular reversal of the flow of Newtonian absolute time also occurs in "Circe". The voices of all the damned sing Handel's "Hallelujah Chorus" backwards and the divine name of the Creator, God, is reversed into its opposite, His creation – dog:

> THE VOICE OF ALL THE DAMNED
>
> Htengier Tnetopinmo Dog Drol eht rof, Aiulella!
> (*From on high the voice of Adonai calls.*)
>
> ADONAI[20]
>
> Doooooooooooog!
>
> THE VOICE OF ALL THE BLESSED
>
> Alleluia, for the Lord God Omnipotent reigneth!
> (*From on high the voice of Adonai calls.*)
>
> ADONAI
>
> Goooooooooood!
> (*In strident discord peasants and townsmen of Orange and Green factions sing* Kick the Pope *and* Daily, daily sing to Mary.) (*U* 15.4707-18).

In this passage we see the reversal from good to bad, God to dog, and Protestantism to Catholicism. In reversing time (and other things) in this fashion, Joyce is at one level suggesting - as he does so often by using chiasmus, e.g. the close of "The Dead", the beginning of "Aeolus" - that Ireland is caught in a religious, moral and emotional time-warp. More broadly, the reversal of time is a challenge to the Calvinistic doctrine of predestination. Newton, of course, believed that his three laws of motion and gravity described how God controlled events in the universe. To Newton, God existed as a kind of omnipotent mechanic who ruled His universe with clockwork precision.

Joyce turns this concept on its head. Predestined final states of blessedness or damnation are dependent only on the direction of time. In "Circe" and "Proteus" time reverses, thus violating the flow of Newton's absolute time. In "Wandering Rocks" the "crumpled paper ball's" apparent reversal of direction was inexplicable by Newtonian

[20] According to the *New American Standard Bible Concordance*, the Hebrew word "Adoni" is an emphatic name for God in the Old Testament (Thomas 1484).

mechanics, but easily explained by applying Einstein's relative motion postulate. It seems that the old time-and-motion premise, which many critics highlighted as a dominant feature of *Ulysses*, can no longer be supported.

BLOOM'S USE OF TIME AND SPACE

All through "Wandering Rocks" characters are defined temporal-spatially by means of frequent allusions to their actual occupation of space and time. In the last scene of the chapter William Humble - Earl of Dudley, John Henry Menton, and Blazes Boylan's attitudes to time were used by Joyce to provide illuminating insights into their psychological identities. How is Bloom using time and space? The answer is surprising: Bloom is grandiosely indulging in time theory and speculative scientific gobbledygook related to Newton and Einstein (and to a lesser extent Vico). He does so, on the whole, to avoid the real issue: his masochistic refusal to intervene in chronometrical time to prevent Boylan and Molly's tryst. Bloom hides himself in scientific theories of time and space as a means of suppressing his true feelings. With deep symbolism, Nosey Flynn tells us about one suspicious woman who went to extraordinary trouble to discover what her husband was up to at secret society gatherings: "- There was one woman, Nosey Flynn said, hid herself in a clock to find out what they do be doing" (*U* 8.971-2). Bloom doesn't hide himself in a clock, but, rather, in theoretical and astrophysical concepts of time and space, as a means of avoiding the real issue confronting him: "what they do be doing".

"What they do be doing" is making adulterous love. At a poignant and significant moment in "Nausicaa" Bloom discovers that his watch has stopped at exactly the moment of greatest emotional devastation – four thirty p.m., the moment of adultery:

> Funny my watch stopped at half past four. Dust. Shark liver oil they use to clean. Could do it myself. Save. Was that just when he, she?
> O, he did. Into her. She did. Done.
> Ah! (*U* 13.846-50).

At first, Bloom speculates that dust caused his watch to stop, then he begins to read deeper significance into the event:

> Very strange about my watch. Wristwatches are always going wrong. Wonder is there any magnetic influence between the person because that was about the time he. Yes, I suppose, at once.... Also that now is magnetism. Back of everything magnetism. Earth for instance pulling this and being pulled. That causes movement. And time, well that's the time the movement takes. Then if one thing stopped the whole geshabo would stop bit by bit. Because it's all

> arranged. Magnetic needle tells you what's going on in the sun, the stars (*U* 13.983-91).

In this passage (to be considered again presently in relation to Einstein), Bloom is using the predictability of Newtonian mechanics to suggest the inevitability of Boylan and Molly's relationship and hence his own inaction. In the reference to Newtonian theory -"Earth for instance pulling this and being pulled" - Bloom is making an allusion to the force of attraction between Boylan and Molly, acting like Newton's universal law of gravitation. When Bloom states, "Because it's all arranged", he is specifically relating the simultaneous stopping of his watch and Molly's adultery to Newtonian theories of mechanistic predestined causality and the clockwork universe.

However, an undercurrent of Einsteinian theory also seems to contradict Bloom's acceptance of Newtonian causality. Three important allusions to relativistic time theory undercut Bloom's position. Bloom's stalled watch mimics the slowing or stalling of time, otherwise known as relativistic time dilation. His references to magnetic influences allude to James Clerk Maxwell's electromagnetic theory on which Einstein's theories are based. Also, Bloom's definition of time comes very close to Einstein's 1905 definition, which related time to the absolute speed of light and the relative motion postulate. To appreciate the importance of each of these points, we need a little more explanation of Einstein's theories.

The epiphany concerning time came slowly to Einstein as he compared Newton's work (the motion of mechanical objects) with James Clerk Maxwell's equations of electromagnetic propagation (the motion of light). When he combined both, Einstein's mathematics showed him that time was unstable and, independently of Michelson and Morley who proved the absolute speed of light, he developed his special theory of relativity. Stephen Hawking explains:

> The Michelson-Morley experiment performed in 1857 ... showed that the speed of light was always the same no matter how the source or the observer was moving. This seemed ridiculous. Surely someone moving toward the light ought to measure it travelling at a higher speed than someone moving in the same direction ... The entire framework of physics became clumsy and ugly. Then in 1905 Einstein suggested a much more attractive viewpoint in which time was not regarded as completely separate and on its own. Instead it was combined with space in a four dimensional object called space-time.

> Einstein was driven to this idea ... by the desire to make two parts of the theory fit together in a consistent whole. The two parts were the laws that govern the electric and magnetic fields, and laws that govern the motions of bodies.... It completely revolutionised our notions of space and time.... It used to be considered obvious that time flowed on forever ... but the theory of relativity combined time with space and said that both could be warped or distorted, by matter and energy in the universe. So our perception of the nature of time changed from being independent of the universe to being shaped by it .... But the philosophers have not yet caught up with the idea ... they don't realize that the frontier of physics has moved on (43-4).

One of the philosophers who almost catches up with the idea that time is shaped by relativity is Bloom.

From Hawking's remarks come four inter-related aspects of relativity theory as it relates to our modern appreciation of time: the instability of time in relation to the laws of motion, the relationship between the laws that govern electromagnetic fields and time, Einstein's definition of time as he related it to the relative motion postulate, and Michelson and Morley, who refuted the ether theory of Newtonian space.

Bloom's stalled watch, as we have seen, implies the stopping of time. Earlier in the novel, Bloom again preempts Einstein when he indulges in a flight of fancy about what it would be like to travel at the speed of light, the speed of the sun, and never grow a day older: "Makes you feel young. Somewhere in the east: early morning: set off at dawn. Travel round in front of the sun, steal a day's march on him. Keep it up for ever never grow a day older technically" (*U* 4.83-6). Whittaker and Jordan find that this monologue of Bloom's has complex relationships with ancient Greek assumptions about time as well as allusions to Einsteinian time. On one level, the passage alludes to Plato's belief in reincarnation and the flight of the eternal soul (27). At a second level, the passage appears to predict a future flight of fancy - that of air travel and the ability to travel across international time zones. Then at a third level, the passage contains an allusion to Einstein's dilation of time - the instability of time in relation to the laws of motion.

Whittaker and Jordan comment on the interplay in the passage between ancient Greek and modern Einsteinian time theories - metempsychosis and time dilation:

> Joyce's irony in this scene is ... complex and requires that we remember that Bloom's existence depends on Book 10 of Plato's *Republic* and that, by 1919 at the very latest, Albert Einstein's 1904 [*sic*] musings on topics similar to Bloom's were common knowledge. The identification of Bloom with Odysseus is the foundational trope of *Ulysses*.... The myth of Er at the close of *The Republic* ... describes the immortality of the soul and the method of its reincarnation. It seems that when we die our souls travel to distant stars for a period of years and return to the great threshing floor where souls and their encasing bodies are separated and united (27).

In Plato's *Republic* the soul of the ancient Greek hero Odysseus is described choosing the form of his metempsychotic reincarnation – that of a humble citizen like Bloom:

> And it fell out that the soul of Odysseus drew the last lot of all and came to make its choice, and, from memory of its former toils having flung away ambition, went about for a long time in quest of the life of an ordinary citizen who minded his own business, and with difficulty found it lying in some corner disregarded by others, and upon seeing it said that it would have done the same had it drawn the first lot, and chose it gladly (516-7).

Whittaker and Jordan comment:

> Following Plato's lead, Joyce re-reincarnates the same soul as one Leopold Bloom, and Bloom's day on the 16 June 1904 rehearses various Homeric adventures and Platonic dialogues. When Bloom muses on gaining immortality by travelling with the sun, his speculation should viewed in the context of his method of incarnation. He exists at all because, as a reincarnation of the soul of Odysseus and Socrates, his soul is immortal and, between incarnations, travels with the sun (28).

However, Bloom does not exist just as a metempsychotic reincarnation of the past ancient Greek hero Odysseus, but also as a prototype of the greatest scientist of the age, Albert Einstein. Whittaker and Jordan go on to write:

> Just as Bloom does not know his precursors, he also does not know that there is another Jew in Europe musing much more effectively than he on such subjects such as how light is absorbed and what happens in the proximity of stars or at the speed of light. At virtually the same time that Bloom wonders about his own relation to time and motion, Einstein was asking the same question concerning what we would see if we traveled at the speed of light (*ibid*).

This question was answered in a series of papers first published in 1905. Some of the implications of these papers then became universally accepted at the time of the 1919 solar eclipse. Whittaker and Jordan observe:

> What Bloom in 1904 cannot have known (but what Joyce certainly would have) was Einstein's conclusion about the relativity of time and motion: by traveling with the light of the sun, Leopold Bloom would indeed not age. What is most instructive about Bloom's musing is that it exemplifies Joyce's general method of uniting very ancient and very modern concepts, in this case, concepts about the ultimate nature of reality (*ibid*).

According to Einstein's special theory of relativity, if one were travelling at the speed of light one would, indeed, not age. Colin Wilson, writing about relativity theory, shows us why this thought of Bloom's is post-Newtonian:

> Time dilation is a real effect, and it affects everything. Not just mechanical clocks, but atomic processes and all physical phenomena are affected in equal proportion.... If *any* process ... did not accord with the time dilation effect it would imply that there exists some kind of [Newtonian] absolute time, and that there is such a thing as absolute space and absolute velocity. Many people when confronted by the phenomenon of time dilation, while being prepared to accept that perhaps mechanical clocks may run slowly at high speeds, refuse to accept that bodytime and the aging process are likewise affected (180).

Actually, there is slightly more to Bloom's flight of fancy about trying to travel at the speed of the sun than Whittaker and Jordan note. David Fisher informs us that, "as a daydreaming small boy", Einstein used to wonder what it would be like to ride along on a sunbeam: "The teacher asked Einstein why he had not attended to his lessons and he answered, 'I was looking at the sunlight. I was wondering what if I could ride along on that sunbeam, go just as fast as it is going'" (15). In the passage under discussion Bloom appears to have a near identical idea when he thinks of sunlight, and significantly his daydream has, like the young Einstein's fancy, a youthful component: "Makes you feel young.... Travel round in front of the sun, steal a day's march on him. Keep it up for ever never grow a day older technically"(*U* 4.83-6). Bloom appears to have already made the connection between the aging process and relative motion at high speeds. And his desire to travel around in front of the light of the sun seems to come close to Einstein's youthful desire to travel on a light beam.

Einstein's biographer, Denis Brian explains how travelling on a light beam and not aging at the speed of light later amalgamated into an epiphany on the relativity of time which mimics Bloom's stalled watch:

> For years he had wondered how things would look to him if he rode on a light beam. Recently he had glanced back at the Bern's clock tower while riding a streetcar and thought, What if the streetcar were moving at the speed of light? Applying his new theory, he decided that the clock would appear to him to have stopped, while the watch in his pocket would continue to run at its usual rate. This confirmed his idea that time is not the same for all observers when objects approach the speed of light (65).

In the special theory of relativity, Einstein's great insight was to associate time algebraically and geometrically with the speed of light: the propagation velocity of the electromagnetic spectrum. Building on James Clerk Maxwell's electromagnetic theory of light, Einstein realised in 1905 that if the velocity of light is absolute and invariant, then for the laws of physics to hold true, time must vary. In a lecture given in Kyoto in 1922, Einstein explained his reasoning:

> I felt certain of the truth of the Maxwell-Lorentz equations in electrodynamics. All the more it showed to us ... the invariance of the velocity of light.... This invariance of the velocity of light was, however, in conflict with the rule of addition of velocities we knew of well in [Newtonian] mechanics.... It was a puzzle not very easy to solve at all.... My solution was ... the very concept of time, that is, that time is not absolutely defined but there is an inseparable connection between time and the signal velocity (Pais 139).[21]

What Maxwell's electromagnetic equations showed Einstein was that electric and magnetic fields are propagated no faster than the absolute speed of light. And that since the equations show nothing can travel faster than light, Newton's hypothesis of an instantaneously propagated force of gravity is impossible. The general theory of relativity builds on this relativity postulate and asserts the existence of gravitational fields (the mass-curvature of space-time) which are propagated in accordance with Maxwell's

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[21] Einstein says in effect, that Newton's absolute time is wrong because it contradicts Maxwell's equations for electromagnetic phenomena. The new absolute is the speed of light *c*; time is therefore variable and relative to motion, and is defined by the speed of light. By the term "absolute" physicists mean some unvarying feature of nature from which it is possible to make fundamental and axiomatic mathematical statements about the world we inhabit. Relativity theory is, therefore, not relativism; if just one example of light travelling at a speed different from *c* were to be proved, the theory of modern physics would collapse.

electromagnetic equations. Bloom alludes to these relationships between time, electromagnetic phenomena, and gravitation in the reference to his stopped watch, which we must consider again from a different perspective:

> Very strange about my watch. Wristwatches are always going wrong. Wonder is there any magnetic influence between the person because that was about the time he. Yes, I suppose, at once ... Also that now is magnetism. Back of everything magnetism. Earth for instance pulling this and being pulled. That causes movement. And time, well that's the time the movement takes. Then if one thing stopped the whole geshabo would stop bit by bit. Because it's all arranged. Magnetic needle tells you what's going on in the sun, the stars. Little piece of steel iron (*U* 13.983-92).

As noted above, we are meant to see huge irony in Bloom's failure to intervene in chronometric time to prevent the adultery, the stalled watch being symbolic. On the other hand, Bloom's pseudoscientific ramblings - here as elsewhere designed to divert his mind from the adultery, while at the same time rationalising it - are expressed half in Newtonian gravitational terms ("Earth for instance pulling this and being pulled") and half in terms of Maxwell's electromagnetic theory ("Back of everything magnetism") coupled with Einstein's time relativity ("And time, well that's the time the movement takes").[22] Hence, Bloom nearly associates time and gravitation with the absolute velocity of the electromagnetic spectrum; he comes close to an Einsteinian time epiphany - but he just fails to see it.

Bloom's definition of time ("And time, well that is the time the movement takes") deserves closer analysis. Fritz Senn believes that Bloom's definition of time is almost meaningless. In "The Narrative Dissimulation of Time" he writes:

> 'Time' is taken in its most naïve, pedestrian, sense – not at any metaphysical level.... When Bloom reflects on the Newtonian universe with its forces of gravity and magnetism, he wonders: "And time?" He answers his question with an *ad hoc* definition, "Well that's the time the movement takes" (*U* 13.988-9), a definition that is circular, tautological, and useless (145).

[22] Here we see Bloom alluding to both Newton's laws of motion and gravitation, and Maxwell's laws of electromagnetic phenomena – the two sets of laws, which Einstein combined into the theories of relativity - mathematically proving the time dilation effect. For further clarification on Bloom's ramblings in relation to Einstein, please review Stephen Hawking's summary on pages 43-4.

Senn is correct insofar as he notes that Bloom's monologue contains references to the Newtonian universe, the forces of gravity and magnetism - an aspect previously discussed. However, Senn fails to recognize that Bloom's stalled watch parodies Einstein's relativity theory including time dilation, which is related to Maxwell's observations of the electromagnetic spectrum. Senn is also incorrect when he states that Bloom's definition of time is "circular, tautological, and useless".

By 1905, Einstein realised that Newton's definition of time was useless. Elton explains this definition as: "A time which does not depend on any natural events or, in the words of Isaac Newton, (1642-1727) 'of itself, and from its own nature, flows equally without relation to anything external'. This idea of time ... by its very definition is unobservable" (28). In contrast, Bloom's 1904 definition of time is quite a good one on two counts. He goes beyond Newton and, like Einstein, he relates time to some relative motion, which is observable. Also, Bloom's definition of time is no more tautological than Einstein's. In 1905 Einstein defined time thus: "We establish *by definition* that the 'time' required by light to travel from A to B equals the 'time' it requires to travel from B to A" ("On the Electrodynamics of Moving Bodies" 40). Nerlich writes of Einstein's statement: "It is hard to overestimate the impact of this remark on philosophy in this century, set, as the words were, in the context of a highly successful, revolutionary theory of physics" (93). For the first time in history, physicists had a working definition of time. In Einstein's "tautological" sentence we have the mathematical definition of a clock - an equation which forever tied the passage of time to the absolute speed of electromagnetic propagation and relative motion. Bloom is already anticipating this idea in 1904.

Building on the Michelson and Morley experiment, which failed to show that the speed of light varied with the relative velocity of the observer, and taking Maxwell's electromagnetic theory as his starting point, Einstein was the first to realise the obvious: the speed of light was absolute and did not vary, being independent of relative motion. Einstein argued that since the velocity of light is an absolute quality and nothing can travel faster, he proposed the principle of the light clock, which maintained that a flash of light travelling over a known distance would always take a certain time; in one second, light travels 299,792 km. However, in applying his own definition of time, Einstein's thought experiments using light clocks and mirrors, bursts and flashes of light, gave

surprising results: unlike light, which is constant, time varies and is relative to the motion and velocity of the observer. It follows that your second and my second are not identical; moving clocks run slow and at the velocity of light, lengths shrink to zero and time stalls altogether. This is the principle of relativistic time dilation. Although Bloom never quite anticipates the idea that time itself stops at the speed of light, he seems to anticipate some related ideas. He thinks of agelessness associated with travelling on a sunbeam. When his watch stalls, he first attributes it to Newtonian theory, then to magnetic phenomena, which he then applies to gravitation. Above all, he gives a post-Newtonian definition of time which relates time to motion, especially the motion of magnetic propagation: "And time, well that's the time the movement takes" - a tautology, a tautology of Einsteinian genius.

Earlier we saw Bloom explaining his non-interventionist masochism by evoking Newtonian predestination in his references to the Ballast Office timeball (*U* 8.109) and to Ireland's royal astronomer, Sir Robert Ball, who wrote the "Fascinating little book" (*U* 8.110-1), *The Story of the Heavens* (*U* 17.1373). Allusion has also been made to the interesting and predictable pattern, whereby Bloom's decisions not to intervene between Molly and Boylan are accompanied by reflections on Ball's astrophysics and Newtonian time concepts, which serve to suppress his masochistic behaviour.

In "Wandering Rocks" we learn that Bloom has exhibited this same pattern of behaviour in the past. On Featherbed Mountain, while Chris Callinan drove and Bloom sat in the front seat waxing eloquent about cosmology and astronomy, Lenehan was sitting in the back of the car lecherously and excitedly fondling Molly's breasts:

> - He's dead nuts on sales, M'Coy said. I was with him one day and he bought a book from an old one in Liffey street for two bob. There were fine plates in it worth double the money, the stars and the moon and comets with long tails. Astronomy it was all about.
> Lenehan laughed.
> - I'll tell you a damn good one about comet's tails, he said. Come over in the sun....
> Coming home it was a gorgeous winter's night on the Featherbed Mountain. Bloom and Chris Callinan were on one side of the car and I was with the wife on the other.... Every jolt the bloody car gave I had her bumping up against me. Hell's delights! She has a fine pair.... His hands moulded ample curves of air....

> - The lad stood to attention anyhow, he said with a sigh. She's a gamey mare and no mistake. Bloom was pointing out all the stars and the comets in the heavens to Chris Callinan and the jarvey: the great bear and Hercules and the dragon, and the whole jingbang lot. But, by God, I was lost, so to speak, in the milky way. He knows them all, faith. At last she spotted a weeny weeshy one miles away. *And what star is that, Poldy?* says she. By God, she had Bloom cornered. *That one, is it?* Says Chris Callinan, *sure that's only what you might call a pinprick.* By God, he wasn't far wide of the mark....
> - He's a cultured allroundman, Bloom is, he said seriously. He's not one of your common or garden ... you know ... There's a touch of the artist about old Bloom (*U* 10.525-83).

Though M'Coy ends by stressing Bloom as the Renaissance "cultured allroundman" interested in literature, art, science, and astronomy, we should be more conscious of Bloom the knowing cuckold.[23] In this case Bloom indulges his scientific curiosity in astronomy, astrophysics and time theory involving the heavens in order to avoid confronting Lenehan.

In "Bloom and the Royal Astronomer" Daniel O'Connell notes that the material for Bloom's impromptu lectures on cosmology here and later in "Ithaca" comes from *The Story of the Heavens* by Sir Robert Ball. That "Fascinating little book", which is on Bloom's bookshelf, is significant for other reasons as well. It is mentioned in the memoirs of Kitty O'Shea, which Michael Patrick Gillespie (108) informs us was in Joyce's library. From it, Joyce would have known about Parnell's interest in Ball's book on astronomy, described thus by Kitty O'Shea:

> During his leisure hours at Eltham Mr. Parnell took up the study of astronomy with that vigour that always characterized him when he was interested in a subject. He had picked out from my bookshelf a book of stars - one of Sir Robert Ball's, I believe - that I bought at random one day, and became at once interested ... I had a fairly good knowledge of astronomy, and ... I was able to tell him much of the stellar systems that was new to him. Finding how he devoured the little book of Sir Robert Ball's, I got several of the latter's interesting works for him (cited by O'Connell 302).

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[23] We can be fairly sure that Bloom knew what Lenehan was doing. He can spot sexual intention. Later in "Nausicaa" we encounter Bloom thinking of Milly's early-developing breasts and associating her sexual desirability with the Featherbed Mountain incident: "Fifteen she told me. But her breasts were developed. Fell asleep then. After Glencree dinner that was when we drove home. Featherbed Mountain. Gnashing her teeth in sleep. Lord Mayor had his eye on her too" (U 13.890-2).

Bloom never quite understands parallax (*U* 8.110-1), Sir Robert Ball's method of reckoning stellar distances based on Pythagorean triangulation, which only works if you assume space-time is flat and the "fixed stars" are non-moving. Perhaps there is also another triangle Bloom fails to comprehend: his own domestic triangle, which parallels the O'Sheas'. There is a congruity between the relationship of Molly, Boylan, and Bloom and Kitty O'Shea, Parnell, and Captain O'Shea. Bloom indulges in amateur astronomy based on Sir Robert Ball's book to avoid thinking about Molly's infidelity with Boylan, while Parnell indulged his amateur astronomy based on Sir Robert Ball's book to enhance the pleasure of his adultery with Kitty O'Shea. Both Captain O'Shea and Bloom take the part of the complacent non-intervening cuckolded husband: Bloom's interest in astronomy is as masochistic as Parnell's is hedonistic.

O'Connell writes:

> The enthusiastic amateur astronomy of both Bloom and Parnell was one aspect of the implicit faith of the nineteenth century in scientific prophets like Sir Robert Ball. The discovery of the planet Neptune in 1846 through the calculations of the French mathematician Le–Verrier was for Ball "the most triumphant proof of the law of universal gravitation". It is a fair sample of the attitude which was communicated to the average interested layman i.e., Bloom. His confidence in mathematics, the belief that it gives structure to a universe of apparent chaos, is based upon his confidence in experts like Ball, who in turn have their faith bolstered by great scientists like Le-Verrier; the system ultimately comes to rest in its prime mover, Newton. In a post-Einsteinian universe we can look condescendingly on Sir Robert's celebration of the "impregnable position" of classical Newtonian physics; but for Leopold Bloom, Le-Verrier's calculations are one additional proof that you can "do anything you like with figures juggling" (302).

However, while Sir Robert Ball and his admirer, Bloom (and presumably Parnell), could laud both the principle of parallax, which made reckoning intra-galactic distances possible in 1838 (Silk 31), and the discovery of Neptune in 1846 as triumphs of Newtonian laws and gravitational predictability, there were two other features of the cosmos which were still persistently inexplicable by Newtonian mechanics in 1904. They were the perihelion shift of Mercury, and the absolute speed of light. These features were a contradiction to Newtonian mechanics. Einstein said so, in the media, and in his theory: "In classical mechanics ... no answer can be admitted ... unless the reason given is an *observable fact of experience*. The law of [Newtonian] causality has not the

significance ... except when *observable facts* ultimately appear as causes and effects"[italics in original] ("The Foundation of the General Theory of Relativity" 112-3).

Likewise, the Arranger of "Oxen of the Sun" comments, "Science, it cannot be too often repeated, deals with tangible phenomena. The man of science like the man in the street has to face hardheaded facts that cannot be blinked and explain them as best he can." (*U* 14.1226-9). "The man of science", who had not faced hardheaded "facts",[24] was, according to Einstein - Newton, and his practitioners - the likes of Sir Robert Ball. Motz and Weaver make this clear:

> It seemed in the last decade of the nineteenth century ... that physics was a complete discipline that had no gap to be filled by new theory - particularly a theory of discontinuity ... but a close examination of the facts ... revealed the vulnerability of the beautiful theoretical edifice that Newton, Maxwell and their followers had constructed: two sets of phenomena could not be explained. The first set consisted of the negative results of the Michelson-Morley experiment (that is their inability to detect the motion of the earth by observing light beams moving in different directions), and the non-Newtonian advance of the perihelion of Mercury. Both puzzles were ultimately to be explained by the special and general theories of relativity ... (195-6).

The explanation for the perihelion shift of Mercury had to await Einstein's general theory of relativity. The physicists' inexplicable failure to detect the absolute motion of the earth first emerged from an experiment by Michelson and Morley, who proved that the speed of light was invariant and constant regardless of the relative motion of the observers. Shallis explains that Michelson and Morley were attempting to find evidence for Newton's absolute space by experiments aimed at detecting the theorised luminiferous ether:

> Nineteenth century scientists suggested that a luminiferous ether pervaded the universe and was the medium that transported light. But if such an ether existed it would surely mean that absolute space existed. Michelson and Morley wanted to establish the existence of the ether by determining the passage of the earth through it (34-5).

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[24] *FW* repeats this allusion to AE (see p 81). Another irony attaches to the Arranger's statement: the "man of science", and also the "man in the street" who is refusing to face "hardheaded facts" is, of course, Bloom who is engaging in all this astrophysics speculation to avoid confronting Boylan and Molly's adultery.

Significantly, Bloom quotes the luminiferous ether theory of light transmission *verbatim*:

> [Light] derived ... from the sun, primal source of heat (radiant), transmitted through omnipresent luminiferous diathermous ether .... A mode of motion ... from the source ... being radiated through the uneven unpolished dark surface of the metal iron, in part reflected, in part absorbed, in part transmitted (*U* 17.262-8).

The significant phrases are "transmitted through omnipresent luminiferous diathermous ether" and "A mode of motion". The ether theory of electromagnetic motion accounted for the movement of light within the parameters of Newton's three laws of motion. It was assumed that light moved through space just like any other mechanical object. So, Bloom is Newtonian - not Einsteinian - with respect to this.

In 1857, Michelson and Morley set out to observe the absolute motion of the earth relative to the state of rest of space, wrongly assuming that the absolute rest of space, as defined by Newton, could be detected. The experiment actually showed that absolute states of rest or motion could not be defined; motion or rest can only be determined relative to some other object. It also failed to establish a differential relative velocity for light. It assumed that light would display a measurable difference in velocity depending on whether you were moving with or against the light ray. Instead, the experiment proved the opposite. The speed of light did not vary regardless of the motion of the observer and therefore the velocity of light was an absolute: " c [the speed of light] = 299,792.458 ± 0.001km/sec. This makes the velocity of electromagnetic radiation the most accurately determined number in physics" (Elton 33). Further repeated attempts at the experiment were unable to establish the mechanical proof of Newton's theories about what space's absolute rest and the earth's true motion were. So, clearly something was very badly wrong with both Newton's theory of absolute space being in a state of absolute rest and also his concept of absolute time. The earth moving at some defined value of absolute velocity through absolute space in a period of absolute time proved to be unobservable nonsense in the Michelson and Morley experiment.

In 1905, Einstein's "On the Electrodynamics of Moving Bodies" postulated the absolute velocity of light and dismissed the ether theory entirely along with absolute states of rest or motion: "The introduction of a 'luminiferous ether' will prove to be

superfluous, inasmuch as the view here to be developed will not require an 'absolutely stationary [Newtonian] space...'" wrote Einstein (38).[25] His dismissal of the ether theory and Newton's absolute space was based on his view that all motion was relative - the relative motion postulate. Einstein stated in the same paper:

> ...the unsuccessful attempts to discover any motion of the earth relatively to the "light medium" [i.e. the ether], suggest that the phenomena of electrodynamics as well as of mechanics possess no properties corresponding to the idea of absolute rest (37).

Pais explains:

> The one preferred coordinate system in absolute rest is forsaken. Its place is taken by an infinite set of preferred coordinate systems ... the inertial frames ... By definition, any two of these are in uniform motion with respect to each other. The preference for uniformity of relative motion makes this version of relativity a special one (138).

At the end of *Ulysses* we encounter a contradiction to Newtonian space, which alludes to Michelson and Morley and also to Einstein's statements from "On the Electrodynamics of Moving Bodies". In this case the "moving bodies" are (or aren't) Bloom's and Molly's:

> In what state of rest or motion?
>
> At rest relatively to themselves and to each other. In motion being each and both carried westward, forward and rereward respectively, by the proper perpetual motion of the earth through everchanging tracks of neverchanging space (*U* 17.2305-10).

This Einsteinian insistence on relative motion at the end of Bloomsday is at odds with Bloom's earlier parroting of the outdated Newtonian ether theory (*U* 17.262-8) and of Sir Robert Ball's Newtonian cosmology of "fixed stars" and "parallax". Again Bloom (or, in this case, perhaps the Arranger) anticipates Einstein without realizing that he is doing so.

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[25] These Einsteinian quotes sound a little odd, which may be because this is how Einstein wrote, or it could be because of translation difficulties.

"In November, 1915 ... Einstein was well aware of the problem of Mercury, and it [the perihelion shift] was one of the first calculations he carried out using his new theory": when the figures fitted, "he later wrote 'for a few days, I was beside myself with joyous excitement'" (Will 93). The slight wobble of Mercury's orbit could now be explained by gravitationally "curved space-time" (*ibid*). Space and time really were curved and not flat as Newton had thought. For the first time in nearly two hundred years Newton's theories were in doubt, and greater doubts were to come in 1919 with Sir Arthur Stanley Eddington's observations of the gravitational curvature of light during the solar eclipse of 29 May. Also eclipsed were the life works of Newtonian mechanistic cosmologists such as Sir Robert Ball. These books were replaced by those written by Einsteinian relativity theorists such as "Whitehead and Eddington"[26], cosmologists whom William Tindall informs us "Joyce was familiar with", and later read in preparation for the *Wake* (91).

To test his new curved space-time theory, Einstein had suggested that the "gravitational red shift of light and clocks" (Will 42) would be observed during a solar eclipse: a shift towards longer wavelengths of red light would occur as time slowed. In 1911 Einstein had written:

> ...one of the most important consequences of my former treatment is capable of being tested experimentally ... that rays of light, passing close to the sun, are deflected by its gravitational field ... by nearly a second of arc.... Thus according to our view the spectral lines of sunlight ... must be somewhat displaced towards the red, in fact by the relative amount ("On the Influence of Gravitation on the Propagation of Light" 99-105).

Einstein's "principle of equivalence" (Will 67) mathematically equates the slowing of time and curving of space, with the proof being the bending and red shifting of light by the sun's gravity. On 29 May 1919, during the eclipse, Eddington proved that light was bent by the gravity of the sun; mass and gravity really did warp time. It was the moment of defeat for Newtonian physics, and the experiments made both A.E.s - Albert Einstein and Arthur Eddington - famous. Indeed, Eddington became the most famous astronomer

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[26] Eddington's *The Mathematical Theory of Relativity* is probably the book Tindall is referring to. The preface to the 1962 reprint reads: "A first draft of this book was published in 1921 as the mathematical supplement to the French edition of *Space, Time and Gravitation*".

of the early twentieth century, gaining a knighthood, while Einstein attained superstar status and the 1921 Nobel Prize. Clifford Will writes of the widespread media attention following Einstein and Eddington's experimental success:

> The headline in the London *Times* of November 7, 1919 read **'Revolution in Science / New Theory of the Universe / Newtonian ideas overthrown'**[27]; it heralded a brave new world in which the old values of absolute space and absolute time were lost forever. To some emerging from the devastation of the Great War, it meant the overthrow of all absolute standards, whether in morality or philosophy, music or art (65).

However, I shall proceed to demonstrate that the experimental methodology used by Einstein and Eddington was plagiarised from an earlier Jewish scientist, one Leopold Bloom.

Bloom had already experimented with the behaviour of light during a self-made eclipse on 16 June 1904, while thinking about astronomical parallax as he loitered about on a Dublin street:

> They passed from behind Mr Bloom along the curbstone. Beard and bicycle. Young woman.
>
> And there he is too. Now that's really a coincidence: second time. Coming events cast their shadows before. With the approval of the eminent poet, Mr Geo. Russell.... A.E.: what does that mean? Initials perhaps. Albert Edward, Arthur Edmund, Alphonsus Eb Ed El Esquire. What was he saying? The ends of the world with a Scotch accent. Tentacles: octopus. Something occult: symbolism....
>
> He crossed at Nassau street corner and stood before the window of Yeates and Son, pricing the fieldglasses.... Must get those old glasses of mine set right. Goerz lenses six guineas. Germans making their way everywhere.... There's a little watch up there on the roof of the bank to test those glasses by.
>
> His lids came down on the lower rims of his irides. Can't see it. If you imagine it's there you can almost see it. Can't see it.

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[27] i. The bold type is in the original.

ii. "In a recent survey of twentieth-century history, the British Historian Paul Johnson argued that the 'modern era' began not in 1900, not in August 1914 [the Great War], but with the event that spawned this headline" (Will 65). The proof of relativity had embedded in it the secrets of atomic energy and modern cosmology. As early as 1905, Einstein had theorised the existence of atomic energy from radioactive isotopes. In "Does the Inertia of a Body Depend upon its Energy-Content?" (the paper which contained the relation $E = mc^2$) he innocently remarked, "It is not impossible that with bodies whose energy-content is variable to a high degree (*e.g. with radium salts*) the theory may be successfully put to the test" [my italics] (71). Indeed it was, in 1945 at Hiroshima!

> He faced about and, standing between the awnings, held out his right hand at arm's length towards the sun. Wanted to try that often. Yes: completely.
>
> The tip of his little finger blotted out the sun's disk. Must be the focus where the rays cross. If I had black glasses. Interesting. There was a lot of talk about those sunspots when we were in Lombard street west. Looking up from the back garden. Terrific explosions they are. There will be a total eclipse this year: autumn some time.
>
> Now that I come to think of it that ball falls at Greenwich time. It's the clock is worked by an electric wire from Dunsink. Must go out there some first Saturday of the month.... what's parallax?...
>
> His hand fell to his side again.
>
> Never know anything about it. Waste of time. Gasballs spinning about, crossing each other, passing. Same old dingdong always. Gas: then solid: then world: then cold: then dead shell drifting around, frozen rock, like that pineapple rock. The moon. Must be a new moon out, she said. I believe there is....
>
> Wait. The full moon was the night we were Sunday fortnight exactly there is a new moon. Walking down by the Tolka. Not bad for a Fairview moon. She was humming. The young May moon she's beaming, love. He other side of her. Elbow, arm. He. Glowworm's la-amp is gleaming, love. Touch. Fingers. Asking. Answer. Yes.
>
> Stop. Stop. If it was it was. Must.... How time flies, eh?...
>
> I was happier then. Or was that I? Or am I now I? Twentyeight I was. She twentythree[28]....
>
> When we left Lombard street west something changed. Could never like it again after Rudy. Can't bring back time. Like holding water in your hand (*U* 8.523-611).

This passage operates at several levels of meaning related to time theory. On the surface, Bloom is wandering about Dublin trying not to think about the inevitability of Boylan and Molly's four o'clock tryst. We observe Bloom suppressing painful psychosexual emotions by indulging in his hobby of amateur astronomy and theoretical aspects of time physics related to Sir Robert Ball's "Fascinating little book". We are also given a clue that Bloom's sexual dysfunction is related to the past and to grief over his son Rudy's death. At this level, Bloom acknowledges the Newtonian concept of the flow of time: "Can't bring back time. Like holding water in your hand."[29]

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[28] Notice Molly's "twentythree", presently we will see its inversion: 32, *ad nauseam.*

[29] Yet, again Bloom's thoughts also hint at another time related theory: Freud's psychosexual theory of the subconscious, which postulates that past experience shapes subconscious identity and affects present and future behaviour. In particular, Bloom wonders about his own ego-identity in relation to time – "How time flies, eh?...I was happier then. Or was that I? Or am I now I? Twentyeight I was. She twentythree". In his next thought ("something changed. Could never like it again after Rudy") we are shown the link between Bloom's sexual dysfunction and his defense-mechanism of suppression, using astrophysics and time theory as the distraction.

At a more symbolic level, the passage uses the concept of a solar eclipse as a vehicle to suggest the inevitability of Bloom being eclipsed by Boylan at four o'clock. The passage begins with the image of an eclipsing shadow: "Coming events cast their shadows before". When Bloom remembers the previous event down by the Tolka - which itself foreshadows what is to come later - he thinks, "There will be a total eclipse this year: autumn sometime". The reference is to both the position of the heavenly bodies – the sun and the earth with the moon between them – and the ecliptic position of the earthly bodies – Bloom and Boylan with Molly between them: "He other side of her".

In particular, Bloom anticipates the "coming event" of the 1919 eclipsing "shadow" when Eddington observed the gravitational bending of light rays passing close to the sun. Will writes:

> Einstein in 1907 was interested in the effect of gravity on light. He recognised that if the principle of equivalence led to an effect on the frequency of light, the gravitational red shift, it should also result in an effect on its trajectory. In 1911, he determined that the deflection of a ray grazing the sun should be 0.875[30] arcseconds. He proposed that the effect be looked for during a total solar eclipse (67).

Bloom comically preempts Einstein's 1911 proposal and Eddington's proof, which confirmed a "victory for general relativity" (Will 78):

> He faced about and, standing between the awnings, held out his right hand at arm's length towards the sun. Wanted to try that often. Yes: completely. The tip of his little finger blotted out the sun's disk ... There will be a total eclipse this year: autumn sometime (*U* 8.564-70).

"Circe" reiterates the same experiment: "*Bloom.... bids the tide turn back, eclipses the sun by extending his little finger*" (*U* 15.1841-51).

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[30] Will adds: "Yet, in November, 1915, Einstein doubled the prediction... the deflection had to be 1.75 arcseconds, not 0.875 arcseconds" (71). This doubled figure arose because the general theory of relativity showed Einstein that gravitation also causes an additional warping of time (0.875 arcseconds) as well as a bending of space (0.875 arcseconds). It was the revised figure which Eddington's experiment proved correct.

These are not the only Einsteinian allusions in the passage. Eddington's observation of the eclipse of the sun proved that Einstein's famous formula, $E = mc^2$, was correct. Einstein's formula concerned the interchangeability of energy and mass; according to Einstein's equation, light had energy and therefore mass. The behaviour of light in the sun's gravitational field - more evident during the eclipse - demonstrated that light behaved just as any other body with mass would behave under the influence of gravity. In addition, the fact that light was subject to gravity and displayed a frequency wave-shift towards the red end of the spectrum showed that light was behaving like a particle as well as a wave. This proved Einstein's electromagnetic theory that light could behave as "both waves and particles (or dual wave-particles)" (Gribbin, *Unveiling* 24). If the former, then it consisted of an electromagnetic field and was unaffected by gravity; if the latter, then it was affected by gravity and fell in a gravitational field. Bloom hints at this dual theory of light when he associates the spectrum with gravitation in "Circe": "Roygbiv. 32 feet per second" (*U* 15. 1605): "Roygbiv" (an acronym for the colours of the spectrum) relates to light acting as an electromagnetic wave and "32 feet per second [per second]" is the acceleration of gravitation. Thus, this association between the light spectrum and the acceleration of gravity makes Bloom even more of a genius. Einstein's theory postulates that any electromagnetic energy, including light itself, will create gravitational waves. We see a parallel between Bloom's ideas and Einstein's. Just as Bloom talked of light and gravity together in 1904, Einstein explained "... the [light] particle itself will create a gravitational field" (Møller 290). Bloom appears to have almost come to this conclusion himself, here and in "Circe".

A further Einsteinian coincidence concerns George Russell's nom-de-plume, the initials,"A.E." Russell received his A.E. pen-name accidentally when a publisher misspelled his original nom-de-plume, "AEON" (Gifford 173). Bloom evidently doesn't know this; "A.E. what does that mean? Initials perhaps. Albert Edward Arthur Edmond"[31]. The same initials might also allude to Albert Einstein and/or Arthur Eddington. Note that the names "Albert" and "Arthur" occur in Bloom's monologue and that they are associated with a coming eclipse.

The reference to A.E.'s "bicycle" may also allude to Einstein. On the one hand, Russell –

[31] Similarly, "A.E.I.O.U." (U 9. 213) – Stephen thinks of his financial debt to George Russell (pen name A.E.) on 16 June 1904, but perhaps this also alludes to Arthur Eddington's intellectual debt to Einstein.

"the mastermystic" (*U* 7.784) – cycled throughout Ireland to engage support for his religious leanings towards atavism, the Theosophical Society and "that Hermetic crowd" that Stephen sneers at in "Scylla and Charybdis". Hence, in "Circe", Russell is described with a cycle pump: "*His right hand holds a bicycle pump*" (*U* 15.2265). On the other hand, the reference to A.E. and his bicycle possibly alludes to a stunt that Albert Einstein used to explain his general theory of relativity to press photographers: he clowned around on a bicycle. To demonstrate his theory that gravity was another form of acceleration – not a universal force as Newton had believed – Einstein would ride around on the bicycle. He showed that the gyroscopic action of the spinning wheels provided a stabilising "force" (a centripetal acceleration) against gravity, allowing the cyclist to stay upright.

Einstein's theory also suggested that gravity might cause "the bending of light" due to "the distortion of spacetime" and resulted in his proposing an effect called "gravitational lensing"[32], whereby far-away objects in time and space might be observed if a strong enough source of gravitation existed to focus the rays (Gribbin, *Companion* 180). In this passage from "Lotus-eaters", we see Bloom has also staked a claim on this idea when he looks at his self-made eclipse and thinks: "Must be the focus where the rays cross" and "Must get those old glasses of mine set right. Goerz lenses six guineas. Germans making their way everywhere". The reference to "Germans making their way everywhere" may allude to the German astronomers' race with the English to test Einstein's theory. Brian informs us that, "at the start of the war [the German astronomer] Freundlich had attempted to test relativity from Russian territory during an eclipse of the sun" (98). However, he failed, and "before Freundlich could make another attempt with Einstein's encouragement he was beaten to it by English astronomer Arthur Eddington" (*ibid*). Bloom, looking at his self-made eclipse, thinking of Germans and then failing to see the epiphany, may reflect Freudlich's failure.

In previous chapters, we have observed Bloom indulging in his hobby of amateur astronomy, musing about the Ballast Office clock, and thinking about parallax and

[32] Eddington's observations during the eclipse also supported Einstein's idea of "the presence of the sun's mass in effect acting like a lens" (Gribbin, *Unveiling* 24).

Sir Robert Ball's "Fascinating little book". We have seen that these musings verge on an Einsteinian epiphany concerning the nature of time, space, energy, and light. The same thing is happening in this passage. Einstein's general theory of relativity shows us that time is specifically related to the velocity of light and the propagation speed of the electromagnetic spectrum. Bloom seems to come close to this relativistic concept when he considers the Ballast Office clock, and observes that time might be related to the speed of a signal down an electrical wire: "Now that I come to think of it that ball falls at Greenwich time. It's the clock is worked by an electric wire from Dunsink". In 1905, Einstein saw a huge "catch 22" problem associated with synchronizing clocks in this fashion:

> ... to synchronize the clocks ... we can use a time signal which is sent from *A* to *B* ... the time signal is propagated with a finite velocity.... It is thus necessary to know the velocity of the time signal, but a measurement of a velocity presupposes ... that two clocks in different places are [already] synchronized, [so we can do the velocity measurement] ... [a] fundamental difficulty.... The concept of simultaneity between two events in different places obviously has no exact objective meaning at all ... [33] (cited by Møller 32).

It was precisely this problem that no time signal has instantaneous propagation which caused Einstein to abandon Newton's absolute time. A new absolute had to be found, and the obvious one was the absolute speed of light. "I never exactly understood" (*U* 8.110), Bloom sighs; "Never know anything about it. Waste of time" (*U* 8.581) he puns. In thinking about synchronicity in this fashion, Bloom is alluding to a problem neither he nor "professor Joly" [*sic*] (*U* 8.573) could resolve prior to Einstein's 1905 theory.

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[33] Møller's summary of Einstein is difficult to follow (Einstein's supporting maths even harder). Essentially he says, we cannot synchronize two clocks at different places by wire (or anything else) until we can measure how fast the synchronizing signal is carried. However, until we have two clocks already synchronized, we cannot measure the speed of the signal – "catch 22". In his reference to "Greenwich time" and his subsequent ramblings, "never know anything about it", Bloom is obliquely alluding to an insurmountable difficulty about Newtonian absolute time. Even today, despite the old time-ball and electric wire apparatus being superseded by Universal Time and radio signals, the problem remains. Only an approximate time is actually possible: Greenwich Mean Time.

Another feature of Einstein's theory was that the convertibility of mass to energy might explain where the sun gets its energy. Einstein's famous formula, $E = mc^2$, darkly hinted at a hitherto unknown form of energy locked within matter itself. This equation indicated that an extremely small amount of mass could be converted to an extremely large amount of energy (later called atomic energy). The previous calculations by classical physicists, which had assumed the sun's energy source was burning bituminous coal, had always yielded nonsense results. Galileo's "construction of his first telescope in 1609" had made the tremendous explosions of sun spots and solar flares readily apparent, but prior to Einstein the source of the sun's energy was unknown (Ronan 260).

Bloom alludes to this when he thinks of the eclipse: "There was a lot of talk about those sunspots when we were in Lombard street west. Looking up from the back garden. Terrific explosions[34] they are." Later in "Cyclops" the Citizen's hurled biscuit tin causes the devastating impact of a similar explosion:

> The catastrophe was terrific and instantaneous in its effect.... All the lordly residences in the vicinity of the palace of justice were demolished and that noble edifice itself, in which at the time of the catastrophe important legal debates were in progress, is literally a mass of ruins beneath which it is to be feared all the occupants have been buried alive. From the reports of eyewitnesses it transpires that the seismic waves were accompanied by a violent atmospheric perturbation of cyclonic character.... Other eyewitnesses depose that they observed an incandescent object of enormous proportions hurtling through the atmosphere at a terrifying velocity in a trajectory directed southwest by west.... You never saw the like of it in all your born puff (*U* 12.1858-97).

In this case a very small mass - "that biscuitbox" (*U* 12.1812), which the citizen " let fly" (U 12.1853) - releases a huge amount of energy. One wonders if Joyce uncannily predicted the coming of the nuclear age.

As well as the atomic age, the new physics began to predict a whole new era of cosmology. Sir Arthur Stanley Eddington's proof of Einstein's general theory of

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[34] This observation of Bloom's is very similar to what was actually seen in 1919: "...slightly after 1:00 ... the eclipse had already begun. With the first view of the sun, however, Eddington swung into action. The eclipse itself was spectacular, with a huge brilliant prominence, a giant flamelike projection from the surface of the sun, visible at totality. But Eddington hardly saw it; he was too busy taking plates (Parker 106).

relativity was the event that birthed modern astrophysics. The classical physicists had simply believed that the universe had always existed in a static state since God's creation. But Einstein's equation - $E = mc^2$ - suggested a startling reality: matter fuelled the stars' energy, and the universe was changing over time. Eventually the cosmos would convert all its mass into energy and billions of years from now the stars would all extinguish. As Stephen Hawking puts it, "No star lives forever, at some point, stars must burn off their fuel" leaving "cold dark matter" (65). Bloom appears to predict this state of affairs when he thinks:

> Never know anything about it. Waste of time. Gasballs spinning about, crossing each other, passing. Same old dingdong always. Gas: then solid: then world: then cold: then dead shell drifting around, frozen rock, like that pineapple rock (*U* 8.581-4).

Despite his statement of ignorance about Ball's cosmology, effectively, Bloom is speaking the language of the new astrophysics. Gribbin and Goodwin, writing in 1997, sound a lot like Bloom, when they explain:

> Using the known laws of physics, studied in laboratories here on Earth, and comparing these with predictions of Albert Einstein's general theory of relativity, astronomers can calculate how an expanding Universe filled with hot gas cooled, and how that gas condensed to form stars and galaxies, planets, and, ultimately, ourselves (*Origins* 20).

Another anticipation of Einstein can be seen in Bloom's musings about light, time, and vision. By linking time with the propagation speed of light, the German Jew, Einstein, predicted that there was a time horizon to our curved universe, which we could never see beyond, or over, no matter how strong our lenses were. This is because the light from those distant parts of space hasn't yet reached us: there exists a space-time event-horizon. For cosmologists to look a long way away is to look back in time, since "we see those distant galaxies as they were when the light left them then, not as they are now" (*ibid*). Also, because space itself is curved and continuously expanding, it is in fact, unclear at what, or where, we are looking. Einstein theorised that we might actually be looking back at light that curves back towards our own past – a somewhat more complicated scenario than Ball's old parallax method. However, Bloom concludes by reverting to Newtonian time: "How time flies, eh?... Can't bring back time. Like holding water in your hand." He is incorrect. Up to the event-horizon, of course you can.

In 1997, Gribbin and Goodwin put this horizon to time and space at "between 12 billion and 15 billion years" (*Origins* 18) - that is, we can see nothing beyond this distance in light years and we can see no further back in time because the light hasn't yet reached us. Bloom comically anticipates this concept too: "There's a little watch up there on the roof of the bank to test those glasses by. His lids came down on the lower rims of his irides. Can't see it. If you imagine it's there you can almost see it. Can't see it" (*U* 8.560-3). Time, in the form of a watch, is beyond what he can see. This amounts to a parody of Einstein's special theory of relativity, and its space-time event-horizon. In addition, Bloom's attempts to see the "little watch" mimics the insight concerning time that Einstein had while looking up at the clock tower of Bern. Yet, despite preempting Einstein and Eddington concerning relativity and the eclipse, by nearly 15 years, Bloom remains in the dark. His inability to see the little clock symbolises his incapacity to see the Einsteinian features of time right in front of his eyes.

BLOOMSTEIN'S FREE FALL *GEDANKENEXPERIMENT*[35]

Einstein's 1905 special theory of relativity is so-named because it applies only in special cases. The algebra shows that time dilation occurs between non-accelerated frames of references, which are in constant relative motion to each other. Yet, what if acceleration is occurring? Einstein, in 1905, did not know how relativity might have to be modified to incorporate acceleration. What about the most pervasive acceleration of all – Newton's gravity: a force of acceleration of 32 feet per second per second? Again, in 1905, Einstein did not know. However, he did know that there was something seriously wrong with Newton's notion of gravity acting as an instantaneous force: "How could Newton's gravity act instantly across the vast distances of space" (Ianotta 28), when $E = mc^2$ showed that nothing could travel faster than the speed of light?

Supposedly, in Newton's second law of motion, a "mass-body could be accelerated up to and beyond the speed of light" (Shallis 39), governed by the equation: force equals mass times acceleration ($F = ma$). However in Einstein's formula, $E = mc^2$, as velocity increases to the speed of light, "mass grows towards infinity" (Pickover 40). To accelerate beyond "the speed of light, an infinite amount of energy" would be required to accelerate an infinite mass – impossibility (*ibid*). It followed that Newton's second law of motion was incorrect at high velocities. Einstein believed that the laws of physics should hold true for all reference frames, not just non-accelerated inertial reference frames; not just special cases where gravity or acceleration is unimportant. According to Hoffmann,

> Einstein ... concluded that he could play no favourites: the equations of physics would have to be expressed in a way that would place all space-time co-ordinate systems on an equal footing, a requirement that he later called the *principle of general covariance* (116).

---

[35] The German *gedankenexperiment* is singular, translating as "thought experiment" whereas *gedankenexperimente* is the plural – "thought experiments". Einstein's theories are based on several hypothetical *gedankenexperimente*. In this chapter I mention only one – the "free fall *gedankenexperiment*", so all references will be in the singular and will refer to this. Einstein sometimes used different accounts – free falling from a cliff, from a house roof, and an elevator – and in all cases it was a natural extension of Newton's falling apple experiment, except the reference frame changed, so that the scientific observer became, in effect, the falling apple.

So, in 1907, with a highly successful theory already to his credit, Einstein turned his attention towards gravity. He wrote,

> When, in 1907, I was working on a comprehensive paper on the special theory of relativity for the *Jahrbuch der Radioaktivität und Elektronik*, I had also to attempt to modify the Newtonian theory of gravitation in such a way that its laws would fit the theory (Pais 178).

In "Lotus Eaters", Bloom – another European Jew – turns his attention from Archimedes' principle to Galileo's law of falling bodies to Newton's force of gravity:

> Because the weight of the water, no, the weight of the body in the water is equal to the weight of the what? Or is it the volume is equal to the weight? It's a law something like that. Vance in High school cracking his fingerjoints, teaching. The college curriculum. Cracking curriculum. What is weight really when you say the weight? Thirtytwo feet per second per second. Law of falling bodies: per second per second. They all fall to the ground. The earth. It's the force of gravity of the earth is the weight.
>
> He turned away and sauntered across the road.... Careless air: just drop in to see. Per second per second. Per second for every second it means (*U* 5.39-52).

Most critics interpret this passage as evidence of Bloom's scientific incompetence. Blamires writes, "The image of the Dead Sea induces in Bloom a series of reflections about the nature of weight and gravity. But he is too somnolent in mood, and too much possessed with another interest, to follow through his scientific calculations" (26). Indeed, when Bloom thinks "It's a law something like that", he ineptly amalgamates three laws: Archimedes' law of displacement, Galileo's law of the equality of falling bodies, and Newton's universal law of gravitation – the force of gravity. The theories of Archimedes are not strictly relevant to this thesis, but for some reason Joyce/Bloom often associates Archimedes with Einstein and also the revivalist preacher, John Alexander Dowie. It is Galileo's law of falling bodies which is uppermost in Bloom's mind, but Bloom's primary consideration is, like Einstein's, an attempt to understand gravity.

In fact, there is a method in Bloom's bumbling cogitation. When he says, "What is weight really when you say the weight? Thirtytwo feet per second per second. Law of falling bodies: per second per second. They all fall to the ground" – that is, with equivalent rates of acceleration: "Thirtytwo feet per second per second" – Bloom is

quoting Galileo's law of falling bodies *verbatim*: "All local bodies fall with the same acceleration" (Hoffmann 107). Then, when Bloom turns his attention to Newton's universal law of gravitation and the force of gravity ("The earth. It's the force of gravity of the earth is the weight"), his reasoning comically comes very close to an epiphany concerning a discrepancy between Galileo and Newton which Einstein experienced in 1907. Hoffmann writes of Einstein's epiphany:

> He had changed the Newtonian theory of gravitation to make it fit the special theory of relativity. But calculation convinced him that, in his new theory, objects with different energies would fall with different accelerations; and this was contrary to Galileo's law that all local bodies fall with the same acceleration. "This law" said Einstein, "which may also be formulated as the law of equality of gravitational and inertial mass, was now brought home to me in all its significance. I was in the highest degree amazed at its existence and guessed that in it must lie the key to a deeper understanding of inertia and gravitation" (*ibid*).

Hoffmann goes on: "What had dawned on Einstein was that there was something suspect in the way Newton's theory accounted for Galileo's law". Einstein saw that Galileo proved the equality of inertial and gravitational mass. If both large and small inertial masses "... all fall to the ground", as Bloom puts it, with equal accelerations of "32 feet per second per second", then inertial mass and gravitational mass must be identical. Moreover, we can see that something like Einstein's epiphany also occurs to Bloom when he says, "What is weight really when you say the weight? ... Law of falling bodies: per second per second.... It's the force of gravity of the earth is the weight". He seems to be beginning to think that Galileo's "Law of falling bodies" and Newton's "force of gravity" don't add up. Bloom's reasoning is very similar to Einstein's; Bloom's consideration of Archimedes' law of the equality of floating weight and displaced water comes very close to Einstein's consideration of Galileo's law of the equality of gravitational and inertial mass. Similarly, Einstein also had huge problems accepting Newton's concept of the "force" of gravity. He eventually abandoned the concept of "force" altogether for the concept of "energy". In the general theory of relativity, Newton's "force" of gravity is non-existent; it is replaced completely by the mass-curvature of space-time existing in Einstein's ten gravitational field equations.

To summarise, Einstein saw that, in contrast to Galileo, Newton had drawn a distinction between the laws of inertia and the laws of gravity; the law of inertia became Newton's first law of motion. The universal law of gravitation was theorised separately by Newton as a universal attractive "force" occurring between heavenly bodies, acting instantaneously, and inversely-proportional to distance. Bloom correctly summarises Newton's gravity: "The earth. It's the force of gravity of the earth is the weight". But, he is also thinking about Galileo's "Law of falling bodies" and correctly stating about large and small masses, "they all fall to the ground" at the same rate and with equal accelerations of "thirtytwo feet per second per second". At this point Bloom is amalgamating Galileo's and Newton's two laws – which was exactly what Einstein saw that he must do in 1907. Ultimately, it is not Bloom's scientific incompetence which is displayed in the passage; it is his brilliance in that he preempted Einstein by three years.

From his epiphany, Einstein figured if inertial mass and gravitational mass were identical, and, according to $E = mc^2$, mass and energy were interchangeable, then gravity must also exist as another form of energy. Perhaps gravity waves existed as energy waves, just as light waves existed as forms of energy? In his Kyoto lecture, Einstein said:

> In 1907, while I was writing a review for the consequences of special relativity ... I realised that all the natural phenomena could be discussed in terms of special relativity except for the law of gravitation. I felt a deep desire to understand the reason behind this.... It was most unsatisfactory to me that, although the relation between inertia and energy is so beautifully derived [in special relativity] there is no relation between inertia and weight. I suspected that this relationship was inexplicable by means of special relativity (Ishiwara 4).

In *Ulysses*, we see Bloomstein becoming increasingly concerned with the same issues: gravity, weight, and acceleration at "32 feet per second per second".

What Einstein most needed was a hypothetical gravity-free environment where he could consider inertia only. Suddenly, in a moment of epiphany, Einstein saw it: his gravity-free environment would exist if the observer threw him or herself down in a state of free fall. It was the free fall *Gedankenexperiment* - which Einstein called "the happiest thought" of my life" (Brian 71). That happy thought overthrew Newton's concept of gravity. In Einstein's own words:

> I was sitting in a chair in the Patent Office at Bern when all of a sudden a thought occurred to me: 'If a person falls freely he will not feel his own weight.' I was startled. This simple thought made a deep impression on me. It impelled me towards a theory of gravitation (cited by Ishiwara 6).

Significantly, the first of several references to Bloom wondering about states of free fall occurs just after the earlier passage involving his musings on Newton's universal law of gravitation, Galileo's law of falling bodies, and Archimedes' law of displacement. In "Lestrygonians" Bloom tests all three laws as he enacts a gravity experiment designed to discover what it would be like if he threw himself down:

> As he set foot on O'Connell bridge a puffball of smoke plumed up from the parapet....
> Looking down he saw flapping strongly, wheeling between the gaunt quaywalls, gulls. Rough weather outside. If I threw myself down?...
> They wheeled lower. Looking for grub. Wait.
> He threw down among them a crumpled paper ball. Elijah thirtytwo feet per sec is com. Not a bit. The ball bobbed unheeded on the wake of swells, floated under by the bridgepiers. Not such damn fools....
> - Two apples a penny! Two for a penny!
> His gaze passed over the glazed apples serried on her stand....
> He halted again and bought from the old applewoman two Banbury cakes for a penny and broke the brittle paste and threw its fragments down into the Liffey. See that? The gulls swooped silently, two, then all from their heights, pouncing on prey. Gone. Every morsel (*U* 8.44-77).

The passage highlights the classical gravity mechanics of Galileo and Newton, which led directly to Einstein's general theory of relativity. According to Boslough:

> Galileo was ... Einstein's and Newton's direct intellectual forebear in the sense that he was the first to define gravitation, Nature's most pervasive yet paradoxically its weakest force.... Newton repaired and refined Galileo; Einstein honed and broadened Newton's basic laws to include the entire universe. Now ... Einstein's general relativity [is] the modern explanation of gravitation and the force, which most concerns cosmologists (34).

In this series of crude gravitational experiments we see references to "apples" (Newton), to falling at the same rate (Galileo) of "thirtytwo feet per sec[ond per second]" (Newton), to Bloom wondering what would happen "If I threw myself down?" (Einstein). Finally "The ball" floats off (Archimedes) to reappear later in "Wandering Rocks",

where, as Hannay shows, it exhibits Einstein's relative motion postulate from the special theory of relativity (1905).

In Bloom's gravitational experiments, he drops first "a crumpled paper ball. Elijah thirtytwo feet per sec is com." and later "bought from the old applewoman two Banbury cakes ... broke the brittle paste and threw its fragments down into the Liffey". This allusion is not only to the fall of Newton's apple but also to Galileo's earlier gravity experiment. Donald Raine informs us that "Galileo dropped two stones, one large, one small, from the leaning tower of Pisa and saw that they hit the ground at the same time" (49) - a result he formulated as the law of falling bodies, which Bloom quoted earlier (*U* 5.39-52).

The passage is full of references to the word "two": "two apples for a penny! Two for a penny!", "two banbury cakes" and "two gulls". This repetition has multidimensional relationships to time theory and gravitation. It suggests Galileo's "two stones" (Raine 49) or perhaps even Galileo's most famous work describing time and falling objects: "*Two New Sciences*, published in 1636" (March 5). It also suggests a fragment of the gravitational constant – 32 feet per second per second. The phrase "Elijah thirtytwo feet per sec is com" may also refer to the Judeo-Christian concept of the Second Coming. Dowie, whose message appears on the crumpled paper ball, believed that he was the reincarnation of the prophet Elijah[36] going forth to announce the Second Coming of Christ (Liardon 38). So Bloom's ball is making widely discursive allusions to time and gravitation.

What is most important in the passage is the series of references to Newtonian physics. Newton established his three laws of motion and confirmed the accelerational force of gravity (the gravitational constant – 32 feet per second per second) after seeing an apple fall. The fall of Newton's apple is suggested here by all the repetitions of the word "apple": "two apples a penny! Two for a penny!", "his gaze passed over the glazed apples", "the old applewoman". But in one respect at least the passage goes beyond Newton. Bloom's thought, "If I threw myself down", could imply a suicidal tendency as

[36] The original Elijah, like Christ, defied gravity in being taken up into Heaven in a whirlwind. At the end of "Cyclops" ben Bloom Elijah also mocks the laws of gravity in his getaway from the Citizen.

most critics believe. Later, the Citizen thinks of murdering Bloom in a similar way: "Gob .... It'd be an act of God to take a hold of a fellow the like of that and throw him in the bloody sea" (*U* 12.1658-62). This idea of either throwing Bloom down, or Bloom throwing himself down, recurs repeatedly in *Ulysses*. However, it can be seen in a very different way – as an anticipation of Einstein's relativistic equivalence-frame thought-experiment of 1907: the "abstract *Gedankenexperiment*" (Hassan 187) - with the scientific observer in free fall, which Einstein called "the happiest thought of my life".

Einstein's biographer, Denis Brian, describes Einstein's epiphany thus:

> ... while he was still in the Patent Office ... Einstein got what he called "the happiest thought" of his life.... The happy thought occurred as he tried to extend special relativity, which applied only to a hypothetical universe where objects moved with constant velocity in gravity-free space. What occurs in the real universe, he wondered, where objects are subjected to gravity and acceleration? He was astonished by the sudden idea that a man falling freely – and accelerating – would not feel his own weight.... Newton saw gravity as a force attracting objects to one another. Not so, said Einstein; objects move in a gravitational field, their paths determined by the curved structure of space.... "From now on," he said, "space and time separately have vanished into the merest shadows, and only a sort of combination of the two preserves any reality" (71-2).

Likewise, in another unpublished account, Einstein himself wrote:

> Then there occurred to me the '*glücklichte Gedanke meines Lebens*', the happiest thought of my life, in the following form. The gravitational field has only a relative existence in a way similar to the electric field generated by magnetoelectric induction. *Because for an observer falling freely from the roof of a house there exists* – at least in his immediate surroundings – *no gravitational field* [his italics]. Indeed, if the observer drops some bodies then these remain relative to him in a state of rest or of uniform motion, independent of their particular chemical or physical nature.... The observer therefore has the right to interpret his state as 'at rest....'
>
> The experimentally known matter independence of the acceleration of fall[37] is therefore a powerful argument for the fact that the relativity postulate

[37] This *ms.* was refused by *Nature* for being incomprehensible to the layperson, and took Einstein two years to rewrite. Einstein's unwieldy phrase, "The experimentally known matter independence of the acceleration of fall" means, Galileo's experimentally proven law of falling bodies: that all mass bodies fall with the same rate of acceleration independently of what they are made of. Bloom's comment is even simpler: "Law of falling bodies .... They all fall to the ground" at "thirtytwo feet per second per second".

> has to be extended to coordinate systems which, relative to each other, are in non-uniform motion (Einstein *Morgan ms.* [38]).

Einstein's free fall *Gedankenexperiment* was the happy moment that launched him towards the gravitational theory of curved space-time: the general theory of relativity. Likewise, in *Ulysses* (and more so in *Finnegans Wake*) there are frequent allusions to the free fall thought-experiment. The most powerful of these relates to the happiest moment in Bloom's life, that moment on Howth Head where he first fell in love with Molly. In "Penelope", Molly remembers this event:

> ... the day we were lying among the rhododendrons on Howth head in the grey tweed suit and his straw hat the day I got him to propose to me yes first I gave him the bit of seedcake out of my mouth and it was leapyear like now yes 16 years ago ... (*U* 18.1572-5).

Ellmann (168) relates Molly's falling in love with Bloom on Howth with the biblical fall of Adam and Eve (through the sin of eating the apple), in the reference to "the bit of seedcake". Falling in love is therefore a fall from innocence into knowledge for Bloom, with the hint of the biblical apple perhaps also carrying an allusion to Newton's falling apple, and the reference to a "leapyear" a further hint towards the *Gedankenexperiment*.

Another transformation of Molly and Bloom falling in love, with Einsteinian overtones, occurs in "Circe" - in the "Bloom / Bello Scene"[39]. The happiest moment of Bloom's life now becomes transmuted both literally and symbolically into its Circean opposite, so that it corresponds to the happiest moment of Einstein's life - the *Gedankenexperiment*:

> BLOOM ....
>
> *(High on Ben Howth through rhododendrons a nannygoat passes, plumpuddered, buttytailed, dropping currants.)*
>
> THE NANNYGOAT

---

[38] *"Grundgedanken und Methoden der Relativitätstheorie in ihrer Entwicklung dargestellt"* in *Morgan ms.*

[39] In this case Fairhall uses this title-convention which I copy. Voelker and Arner adopt the same convention when refering to the "Messianic Scene" in *U* 15.

(*bleats*) Megeggaggegg! Nannannanny!

BLOOM

(hatless, flushed, covered with burrs of thistledown and gorsespine) Regularly engaged. Circumstances alter cases. *(he gazes intently downwards on the water)* Thirtytwo head over heels per second. Press nightmare. Giddy Elijah. Fall from cliff. Sad end of government printer's clerk.

(Through silversilent summer air the dummy of Bloom, rolled in a mummy, rolls roteatingly from the Lion's Head cliff into the purple waiting waters.)

THE DUMMYMUMMY

Bbbbbllllllblblblblobschb!

....

BLOOM

Done. Prff!

(*U* 15.3367-90).[40]

Notice, in this passage, the pun on the gravitational acceleration constant: "thirtytwo head over heels per second [per second]" - where two of those 32 "feet" (per second per second) are Bloom's own "heels". Also, we observe the parallel syllepsis associating Bloom's falling "head over heels" in love with Molly and his simultaneously falling literally head over heels as he "*rolls roteatingly* [*sic*]" from "*Lion's Head cliff*". This fall from the cliff is similar to Einstein's weightless free fall *Gedankenexperiment*. Therefore, Bloom is his own Einsteinian weightless mass-body equivalence-frame thought-experiment in more ways than one: he is falling in love, he is falling as a dead body (the "DUMMYMUMMY"), he is falling as a Newtonian mass-body ("Thirtytwo head over heels per second"), he is falling as a literal example of Galileo's law of falling bodies, he is falling as an Einsteinian weightless rotating[41] mass-body. He is even perhaps free falling in the guise of Einstein himself: "Sad end of government printer's clerk" (*U* 15.3375-6. At the time Einstein conceived the free fall thought-

[40] This passage is full of temporo-spatial and gravitational ironies. Note again the metempsychotic reference to "giddy Elijah" now associated with the downfall of Bloom, himself free falling, who is the nemesis of John Alexander Dowie, who fell from grace with his arrogant and unbiblical assumption of the original prophet's identity, Elijah, who originally ascended to Heaven in a whirlwind, presumably giddy when he got there.

[41] Einstein's theory for relative rotating motion is very complex. However, mention is made of Einstein's explanation for the "rotating bucket" experiment, and the "gyroscopic" effect in the turning bicycle wheels.

experiment which began the general theory of relativity, he was actually employed as a Government printer's clerk[42] in Bern: "I was sitting in a chair in the Patent Office at Bern, when all of a sudden a thought occurred to me: 'If a person falls freely, he will not feel his own weight', it was the happiest thought of my life" (Foreword. *The Foundation of the General Theory of Relativity*). Kip S. Thorne writes that Einstein concluded:

> If you fall freely (for example, by jumping off a cliff), not only will you not feel your own weight, it will seem to you, in all respects as though gravity had completely disappeared from your vicinity ... you cannot discern whether you are falling toward the ground below or [you] are floating freely in space, far from all gravitating bodies (97).

In case we didn't get it the first time in "Circe", Joyce repeats the *Gedankenexperiment* literally in "Ithaca":

> Bloom's decision?
>
> A stratagem.... he climbed over the area railings.... and allowed his body to move freely in space by separating himself from the railings and crouching in preparation for the impact of the fall.
>
> Did he fall?
>
> By his body's known weight of eleven stone and four pounds in avoirdupois measure, as certified by the graduated machine for periodical selfweighing... (*U* 17.83-93).

In the passage, notice the similarities to Einstein's equivalence postulate: " ... you cannot discern whether you are falling toward the ground below or [you] are floating freely in space far from all gravitating bodies" (cited by Thorne 97). Bloom doesn't just jump from his area railings; it is reiterated several times that he falls in a manner which has technical associations with gravity, weight, and free movement in space.

---

[42] A job Einstein referred to as "a venerable federal ink shitter" (Brian 69).

Stephen's contemplations of space and time in "Proteus" are somewhat similar. This thesis focuses on Bloom's cosmology, but Stephen's thoughts relate to Bloom's from time to time. Here, Joyce has chosen to have Stephen walk along the beach at Sandymount. He is nowhere near a cliff, but in the middle of thinking about space and time, he has a bizarre thought about free falling from one:

> Stephen closed his eyes to hear his boots crush crackling wrack and shells. You are walking through it howsomever. I am, a stride at a time. A very short space of time through very short times of space. Five, six: the *Nacheinander*. Exactly: and it is the ineluctable modality of the audible. Open your eyes. No. Jesus! If I fell over a cliff that beetles o'er his base, fell through the *Nebeneinander* ineluctably! I am getting on nicely in the dark....
>
> Open your eyes now. I will. One moment. Has all vanished since? If I open and am for ever in the black adiaphane. *Basta*! I will see if I can see.
>
> See now. There all the time without you: and ever shall be, world without end (*U* 3.10-28).

Pierre Vitoux argues that when Stephen closes his eyes he is actually enacting Bishop Berkeley's distinction between visible and invisible reality, matter and spirit, "*Nacheinander* and *Nebeneinander*" (161-4). Berkeley used these distinctions to describe differences between space and time in his book *A New Theory of Vision*; it is ironical that Stephen has his eyes closed as he comically enacts the title of Berkeley's book. Berkeley, a critic of Newton, believed in the "non existence of matter" (*ibid*) and argued that matter existed only if comprehended through the five senses, especially sight. Significantly, Vitoux thinks that Stephen is testing Berkeley's distinction between visible and invisible realities. When Stephen opens his eyes and asks, "Has all vanished?", his answer - "See now. There all the time without you: and ever shall be, world without end" - is ambiguous. It could mean three things: time and space are "without him" - external from Stephen; time and matter will continue to exist "without him" - after his death; eternity exists "without him" - his soul is not infinite or indestructible. The second of these interpretations would refute Berkeley's idealistic philosophy; time, space, and matter have continued to exist while Stephen had his eyes closed. They have not disappeared simply because they are not being viewed.

Stephen's references to Bishop Berkeley also bear some relationship to Einstein in that both men challenged Newton. Later, we encounter Stephen thinking, "The good

bishop of Cloyne took the veil of the temple out of his shovel hat: veil of space (*U* 3.416-7). This reference is to Berkeley's challenge to Newton's absolute space, by means of the "rotating bucket" experiment (*Principles* 79). According to Berkeley, Newton's laws of motion could explain why water climbed the walls of a bucket which was rotating, but lacked a suitable explanation for the reverse: if the bucket was held stationary and the whole universe rotated instead, would the water still climb the sides of the bucket? It would. Yet, Newton had theorised that it would not. Berkeley's problem was a forerunner of Einstein's relative motion postulate. " 'It suffices, to replace absolute space' opined Berkeley, 'by a relative space.... We may find all the absolute motion we can frame an idea of, to be at bottom no other than relative motion' " (cited by Davies and Gribbin, *Matter Myth: Dramatic Discoveries* 70). The answer to Berkeley's experiment was easy for Einstein to explain. He showed that the whole of matter exists as interdependent, electromagnetic and gravitational fields propagated in time at the speed of light. The mass of water in the bucket and the universe are connected by gravitational fields so it does not matter which is in motion. Berkeley could not go so far because mathematical proof was not sufficiently advanced until Einstein's 1916 general theory of relativity proposed the mass-curvature of space-time. The best Berkeley could do was to claim, "absolute space seems therefore to be mere nothing ... circular motion ... is relative in its own nature" (*Works* 47). His skepticism about Newton's absolute space and relative motion was justified, but was a hunch rather than a mathematically defined theory. So Stephen's thoughts, like Bloom's, especially in the context of space and time and their relationship to motion are related to Joyce's intimations of Einsteinian theory.

On the other hand, Vitoux recognises in Stephen's thoughts an undercurrent of opposition to Berkeley's idealist beliefs deriving from all the allusions to Aristotle's "realism" (162). These two opposing classical time-space theorists, Berkeley and Aristotle, exist in a state of tension, creating a kind of "protean flux" to the text (165). Aristotle's realism, in its way, also appears to be a forerunner of Einstein's theory of relativity. Relativity theory predicts that time and space can only be defined relative to some change of motion or position or other quality of matter - typically the movement of a particle of light (Nerlich 93). Similarly in the *Physica*, Aristotle stated, "we measure movement by the time, but also the time by the movement, because they define each

other" and "we describe the time as much or little, measuring it by the movement" (220b). We can see that Aristotle came up with an argument concerning time and relative motion which Einstein later explained mathematically - the relative motion postulate. So, when Stephen thinks, "You are walking through it howsomever. I am, a stride at a time. A very short space of time through very short times of space", he is literally enacting Aristotle's argument, Berkeley's challenge to Newton and, unbeknown to him, Einstein's theory of time, space and relative motion.

All of this might be a coincidence, were it not that Stephen also has the bizarre thought of falling from a cliff when he is nowhere near one: "No. Jesus! If I fell over a cliff that beetles o'er his base, fell through the *Nebeneinander* ineluctably!" Vitoux interprets Stephen's thoughts as irrational fear when he says, "...as he strides slowly forward, he begins to overcome the fear which his imagination represents in the form of the cliff of Elsinore 'that beetles o'er his base'" (164). Perhaps another interpretation, taking into account all the references to Aristotle's theory of time, space, and motion, the reference to Berkeley and all the emphasis on "time" (mentioned five times) and "space" (three times), is that the passage contains an allusion to Einstein's free fall *Gedankenexperiment*. If so, not only Bloom but also Bloom's alter ego and surrogate son, Stephen, is questioning Newton's theories and coming very close to relativity.

Joyce repeats the *Gedankenexperiment* again in "Circe's" "Messianic Scene":

> AN APPLEWOMAN
>
> He's a man like Ireland wants.
>
> BLOOM
>
> My beloved subjects, a new era is about to dawn. I, Bloom, tell you verily it is even now at hand. Yea, on the word of a Bloom, ye shall ere long enter into the golden city which is to be, the new Bloomusalem in the Nova Hibernia of the future.
>
> *(Thirtytwo workmen ... construct the new Bloomusalem.... In the course of its extension.... Several paupers fall from a ladder. A part of the walls of Dublin, crowded with loyal sightseers, collapses.)* (*U* 15.1539-55).

Platt writes, "Thus Bloom accepts the death of paupers constructing the new Bloomusalem as a worthy sacrifice" (53). On the one hand, Bloom's inflated rhetoric mimics John Alexander Dowie's preaching, his claims to prophetic identity and his grandiose plans in building "Zion City, Illinois" (Voelker & Arner 284). Voelker and Arner explain that, "The sequencing of Bloom's rise and fall in the 'Messianic Scene' copies the pattern of Dowie's career after the establishment of Zion". Eventually Dowie did just what Bloom does in the passage above, he "pauperized" and "sacrificed" his followers by his flamboyant schemes (Liardon 55). On the other hand, in the reference to "*Thirtytwo*", the passage contains an allusion to gravitational acceleration, the "*fall*" of Newtonian physics and the rise of a "new era". Newtonian mass-bodies ("*Thirtytwo workmen*") falling at the rate of 32 feet per second per second are satirised into the actual falling bodies of "*paupers*". These falling paupers may be seen to allude to Einstein's free fall *Gedankenexperiment*: the seminal moment of epiphany which eventually transformed Einstein from a poverty-stricken Government Patent Office clerk into the New Messiah of physics.

And what of "...the new Bloomusalem"? The name is a combination of Bloom's name, the USA, and Jerusalem. Voelker and Arner relate it to "Dowie's Zion City, Illinois" (284), indeed, constructed in the USA. But, their interpretation does not fully explain why the gravitational allusions to "*Thirtytwo*", actual falling bodies and the reference to "AN APPLEWOMAN" appear in this passage. An explanation for these physics references is more likely to be found in Einstein's than in Dowie's biography.

In 1921, the same year that Joyce was completing "Circe"[43], Brian informs us that Einstein was touring the USA lecturing on behalf of Dr Chiam Weizmann, leader of the World Zionist Organisation and raising funds for building projects in Jerusalem (120). Einstein's tour was such a success that he raised over one million dollars "for the planned Hebrew University in Jerusalem ... receives the Barnard Medal", "He is received at the

[43] Groden has calculated, "Joyce began to work on 'Circe' in May and June of 1920" (167) continuing until "second Feb 1922" (203) and, that "parts of the Messianic scene [*sic*] he did not write at all until the summer of 1921 (195), suggesting that he revised them when he knew what Einstein was up to. In these same years, following Eddington's success of 1919, Einstein became a media superstar. For Einstein, these years can be summarised as worldwide scientific acclaim abroad, and rising persecution at home as Germany became increasingly anti-Semitic: just like Bloom in the "Messianic Scene".

White House by President Harding. Visits...Chicago, Boston, and Princeton where he gives four lectures on relativity theory" and on his return trip through London he "visited Newton's tomb" (Pais 526). Einstein, like Bloom, was literally constructing a new "Bloomusalem" - a new university in Jerusalem.

While this passage uses the gravitational acceleration constant - 32 feet per second per second - to focus on the fall of Bloom, other passages focus instead on the fall of Newton and his physics. We have seen that Einstein's 1907 G*edankenexperiment* is alluded to many times in *Ulysses*. In *Finnegans Wake* too, the concept of the "fall" and the figure "32" are developed into almost obsessional leitmotifs. In the Foreword to *A Shorter Finnegans Wak*e Anthony Burgess writes, "32 feet per second [*sic*] is the rate of acceleration of all falling bodies, and the number itself will remind us of the fall of Adam, Humpty Dumpty, Napoleon, Parnell and also HCE himself, who is all their reincarnations" (10). In "The Relativity Theory in *Finnegans Wake*" (*JJQ* 61-70) Andrzej Duszenko adds the fall of Newton and his physics, which, based as it was on an epiphany concerning a falling apple, is related to Adam and Eve's biblical fall through the sin of eating the apple. Duszenko states:

> The fall of classical physics and the emergence of relativity in itself illustrated one of Joyce's main motifs in the *Wake*: that of the fall and resurrection or the constant renewal of the world. This collapse of Newtonian physics is associated in *Finnegans Wake* with the fall of the apple, both the fall of fruit as a symbol of nature's cycle of renewal and the fall of the apple that presumably effected Newton's insight into the similarity between earthly and heavenly bodies as he suddenly saw a likeness between the falling fruit and the movement of the moon. Through the apple image, the modern fall of classical physics is linked in the *Wake* with the biblical fall, and sometimes the two motifs are interrelated (*JJQ* 62).

Joyce, always a rebel and iconoclast, takes obvious pleasure from the fact that what had once been taught as indisputable and axiomatic truth – Newton's physics – was by 1919 a fragmented eggshell of a theory. Sir Isaac Newton was a fallen Humpty-Dumpty-like figure (*FW* 3.30, *FW* 106.20). The *Wake* begins with "Finnegan's Fall", and on page three we read "...a kidscad buttended a bland old isaac.... The fall ... The great fall of the offwall ... the humptyhillhead..." (*FW* 3.10-20). The "humptyhillhead" fall may refer to Bloom's earlier falling in love on Howth Head, which in turn was based on the

Gedankenexperiment. The reference to Isaac could refer to both Jacob's deception of Isaac (*Genesis* 27) and Einstein's overthrow of Sir Isaac Newton. Reinforcing this same theme, Newton's and Einstein's names are alluded to in "The Manifesto of ALP": "*Lumptytumtumpty had a Big Fall ...the Fall of Fruit ...Eye, Seen Aples ... from Back to the Front, Abe to Sare Stood Icyk Neuter*" (*FW* 106.20-9). We see Einstein's names – "*Eye, Seen*" - and also Sir Isaac Newton's – "*Sare ... Icyk Neuter*" associated with the "*Big Fall*", "*Aples*" and "*the Fall of Fruit*". In fact "The Fall" (*FW* 3.15) and "The Great Fall of the offwall" (*FW* 3.18-9), that is, the free fall experiment, are alluded to continually.

So is the 32 feet per second per second acceleration of gravity - at *FW* 13.33, 14.11, 36.17, 61.9, 65.27, 69.33, 95.32, 105.30, 113.14, 116.16, 120.25, 128.17, 131.1, 182.23, for example. And, Joyce seems obsessed with Einstein's name: "oldsteinsong" (*FW* 231.29); Einstein's intelligence - "Eyeinstye! Imagine it, my deep darty dullard!" (*FW* 305.6); his love of classical music - "For auld lang salvy steyne" (FW 305.29); and even with the *Gedankenexperiment* - "as a fatter of macht, Dr Gedankje[44]..." (*FW* 150.11). Therefore, part of the *Wake* amounts to a "ridiculisation of whoo-whoo and where's hairs theorics of Winestain" (*FW* 149.27-28) and "a quantum theory about it" (*FW* 149.35). Moreover, Joyce gives us a clue to interpret at least some of the *Wake* within the curvilinear geodesics of *Einstein's* curved space-time when he writes: "These ruled barriers along which the traced words, run, march, halt, stumble at doubtful points.... It is seriously believed by some that the intention may have been geodetic" (*FW* 114.7,8,13-15).

Albert Einstein and Isaac Newton's names are alluded to together in relation to the fallen apple in *Finnegans Wake*. In "Riddles - the Personages of the Manifesto" the *Wake's* Professor asks, "What secondtonone myther rector and maximost bridgesmaker was the first to rise taller through his Beanstale...?" (*FW* 126.10-11). One of the answers

[44] As a matter of fact, this reference is a complex allusion to both Albert Einstein ("Dr Gedankje") who based his physics on thought experiments, and also his fact-based science - built on his predecessor Ernst Mach ("a fatter of macht"). Brian informs us, in 1898 Einstein attended Zurich Polytechnic, where "...a friend ... recommended Ernst Mach's *Science of Mechanics* which ridiculed the concept of absolute space and absolute motion and suggested that Newton's laws should be reexamined and rewritten. Einstein loved this no-nonsense attitude, and [Einstein's friend] Besso believed it was Mach's influence that led Einstein into thinking of 'observables – [i.e. observable facts] and to become profoundly skeptical of concepts like absolute space and absolute time' " (19).

the Professor gives us identifies the person as Albert Einstein. Einstein rose taller than Newton when he redefined Newtonian gravitation, the theory based on the falling apple: "... albert solemenly over his hullender's epulence; thought he weighed a new ton when there felled his first lapapple" (*FW* 126.15-16). Furthermore, there is perhaps even a reference to Einstein's *Gedankenexperiment* in the concluding clause: "thought he weighed a new ton when there felled his first lapapple".

A few pages further on in *Finnegans Wake,* the Professor informs us that this "albert" character based his theories on " ...(Maxwell, clark)..." (*FW* 130.11). We know that Albert Einstein based his relativity theory on the equations of James Clerk Maxwell's electromagnetic theory. Highfield notes: "Einstein decided that electromagnetic waves were ultimate, irreducible realities.... By using abstract mathematical representations, he enforced a line of approach begun by Maxwell's electromagnetic theory" (76). One of Einstein's greatest insights was to apply the principle of relativity to light. Taking the mathematical equations of James Clerk Maxwell he argued that the velocity of light is absolute. We can see here that Joyce again alludes to Einstein's theory of relativity.

Similarly, the *Wake's* Professor tells us that somebody with a name very like Edison or Eddington's, "an eddistoon amid the lampless, casting swannbeams on the deep" (*FW* 127.15-6), observed something to do with sunbeams and possibly the darkness of a solar eclipse to support the "Winestain" theory. Edison invented the electric light bulb whereas Eddington observed the gravitational red shift of light proving Einstein's theory. That this "eddistoon" is Eddington is suggested by the ensuing passage, which seems to allude to the red shift of light: "and he was their hero; pink sunset shower, red clay cloud sorrow of Sahara, oxhide on Iren.... marigold window with manigilt lights, a myrioscope, two remarkable piscines and three wellworthseeing ambries..." (*FW* 127.25-34).

There are two further allusions well worth noting in this passage. The first is the reversal of the figure 32: "two remarkable ... three wellworthseeing". Again, since Edison had nothing to do with gravitation whereas Eddington's observations confirmed gravitational red shift, "eddistoon" is more likely to signify the latter. The second allusion is to the report of the 1919 expedition to photograph the sun during the total

eclipse: "...a colleague said, 'Professor Eddington, you must be one of the three persons in the world who understands relativity!' To which Eddington demurred. The colleague persisted, saying, 'Don't be modest, Eddington.' Eddington replied, 'On the contrary, I am trying to think who the third person is'" – implying that only two persons, Einstein and Eddington, understood the new theory (Will 11). Again, the "eddistoon" in Joyce's text seems likely to be Eddington and "two remarkable piscines and three wellworthseeing ambries" may allude to the episode just described. All these references further support Duszenko's claim that one of the main motifs of the *Wake* is the emergence of relativity itself (*JJQ* 62). But it is my contention that the W*ake* merely develops the relativity motif found in *Ulysses*.

In *Ulysses*, we see this same opposition between Newtonian physics and Einsteinian relativity theory; the text frequently alluding with half a leer or half a sneer at one, other, or both. Usually Bloom is the vehicle of Joyce's satire. In "Circe", for example, Bloom whines about his impending old age, and the passage, with its reference to "thirtytwo feet per second [per second]" becomes an oblique sneer at Newton's useless decline in later life:

> I stand, so to speak, with an unposted letter bearing the extra regulation fee before the too late box of the general[45] postoffice of human life. The door and window open at a right angle cause a draught of thirtytwo feet per second according to the law of falling bodies *(U* 15.2778-82).

Motz and Weaver write of Newton's later life of decline:

> Even as Newton became the living symbol of the Age of Reason, he strayed from science and began an arduous, though unsuccessful, effort to show how base metals could be transmuted into gold and wrote lengthy though completely useless treatises about chemistry.... In 1692, Newton suffered a nervous breakdown.... Newton was elected president of the Royal Society in 1703, and he continued to occupy that position until his death. He was also elected a Member of Parliament in 1689, but he never made a speech during his several years in office and spoke up only once to ask that an open window be closed (49).

[45] Note the word "general" here. Perhaps, just a hint of Newton's decline, related to the general theory of relativity? The same word occurs again in the "Commendatore" reference, on page 86.

When Bloom comments, " The door and window open at a right angle cause a draught at thirtytwo feet per second according to the law of falling bodies", he is mimicking Newton's one and only speech in Parliament.

In "Cyclops" we see Joyce sneering at Einstein. The Arranger calls Bloom "The distinguished scientist Herr Professor Luitpold Blumenduft" (*U* 12.468). In "Cyclops" names are significant. The Citizen represents the kind of one-eyed nationalism which plunged the world into the First World War (*U* 12.1364-5). Pisser Burke's name is symptomatic of his bladder trouble (*U* 12.560-72). So, what about the name given to Bloom at this point? On the one hand, the German honorific "The distinguished scientist Herr Professor", was a title frequently applied to Einstein when he took up his post as research Professor at the Prussian Academy University of Berlin after 1913 (Pais 523). On the other hand, "Luitpold Blumenduft" may be an allusion to Einstein's early academic failure. As a day-dreaming small boy, Einstein attended "Luitpold Gymnasium" in Munich, 1888-1895, where his teachers told him "you will never amount to anything" and he was even advised by his Greek teacher to leave school (Hoffmann 19-20). Just as the Arranger calls Bloom "Blumenduft", so Einstein's Luitpold teachers considered him blooming daft. The Arranger's intended put down of Bloom thus contains an allusion both to Einstein's earlier academic failure and to his later success.

BLOOM AND THE CURVATURE AND RECYCLING OF SPACE AND TIME

In "Ithaca" we read of the contents of Bloom's drawer:

> What did the first drawer unlocked contain?
>
> .... an old sandglass which rolled containing sand which rolled.
> ... 3 letters in reversed alphabetic boustrophedonic punctated quadrilinear cryptogram
> .... two partly uncoiled rubber preservatives with reserve pockets, purchased by post from Box 32, P.O., Charing Cross, London, W.C.
> ... 1 Dozen ... envelopes.... now reduced by three:
> ... 2 erotic photocards
> ... purchased by post from Box 32, P.O., Charing Cross, London, W.C.
> (*U* 17.1774-1813).

The passage, in its constant juxtaposing of three of this and two of that, anticipates the *Wake*, where the combination of threes and twos and the number "32" are all suggestive of the acceleration of gravity. But the *Wake* ultimately refutes Newtonian linearity by virtue of the fact that its ending curves back to its beginning. Similarly, this passage relates gravitation to non-linear time in that reference to the rolling hourglass. Traditionally, the sand flowing through the hourglass has been used as a symbol of the linear passage of time; "Like sand through the hourglass, so are the *Days of Our Lives*" is the clichéd opening line of a television soap opera. This time-as-flow can be seen to be specifically linked to Newtonian mechanics, in which "absolute true and mathematical time ... flows equably from past to future without regard to anything external" (Nerlich 225).

Einstein flatly rejected Newton's belief that this "absolute true and mathematical time" flowed equally throughout the Universe, mechanically, like sand through an hourglass. In addition, Eddington's famous observation of the gravitational red shift of light proved conclusively that time does not behave in the linear fashion that Newton had supposed. Moreover, in the general theory of relativity, Einstein's ten mathematical equations show that time is warped or curved by gravity, space, matter, and acceleration, including rotational acceleration. P. C. W. Davies explains that in developing the general theory of relativity, "Einstein had to provide a set of mathematical equations which

describe precisely *how* a given source of gravitation curves the space-time manifold in its vicinity" (104). Significantly, in Bloom's rolling hourglass, the sand no longer measures linear time. It is implied that time has been warped by gravity, hence all the references to 32 in the passage. Like Einsteinian relativistic time itself, Bloom's time simply rolls with the motion of the glass.

Another obscure passage, which hints at gravity having this strange effect on time, occurs in "Cyclops", when the Commendatore takes the timepieces and hides them in his 32 pockets:

> Commendatore Beninobenone having been extricated from underneath the presidential armchair, it was explained by his legal adviser Avvocato Pagamimi that the various articles secreted in his thirtytwo pockets had been abstracted by him during the affray from the pockets of his junior colleagues in the hope of bringing them to their senses. The objects (which included several hundred ladies' and gentlemen's gold and silver watches) were promptly restored to their rightful owners and general harmony reigned (*U* 12.584-91).

One interpretation of these events is that gravity (symbolised by the Commendatore's "thirtytwo pockets") has the ability to steal time ("several hundred ladies' and gentlemen's gold and silver watches"). Again, only Einstein's general theory of relativity describes gravity behaving in such a bizarre fashion.

In *The Matter Myth: Towards 21st-Century Science* Paul Davies explains how gravity is a phenomenon of curved space-time:

> The boldness of Einstein's approach to the puzzle of gravity and nonuniform motions was the abandonment of the idea of flat space, and the introduction of a curved spacetime. Having demolished Newton's mechanics with his special theory, in 1915 Einstein abolished Euclidean geometry as a description of space with his general theory.... The idea that space and time can be distorted by *motion* was extended to include the influence of *gravity*, so that the presence of matter in spacetime would also cause distortions, or warpings, of space and time (86-7).

Stephen Hawking makes the point that many of the modern relativity theorists have researched the possibility of time warps:

> Imagine the outcry about the waste of tax-payer's money if it were known that the National Science Foundation were supporting research on time travel. For this reason, scientists working in this field have to disguise their real interest by using technical terms like "closed time-like curves" that are code for time travel (cited by Pickover Acknowledgements v).

Similarly, Thorne writes of *Black Holes and Time Warps: Einstein's Outrageous Legacy,* and Gribbin describes "wormholes in space-time", "space-time tunnels", and "closed time-like loops" (*Companion* 424, 406, 373). Barry Parker's *Cosmic Time Travel* is typical in its use of this time-jargon: "If such wormholes do exist, and literally all scientists working in the area believe they do, they might somehow be expanded ... into a time machine. We have learned much about time and time travel ... we will look at the theory that started it all - the general theory of relativity" (9).

The relativity theorists' idea of a "closed time-like loop" in which the whole of history is recycled in space and time would have appealed to Joyce. In "Calypso" Bloom explains the same concept. Only the jargon is different - "metempsychosis":

> - Met him what? He asked.
> - Here, she said. What does that mean? ...
> - Metempsychosis? ...
> - Metempsychosis, he said, frowning. It's Greek: from the Greek. That means the transmigration of souls.
> ...He turned over the smudged pages. *Ruby: the Pride of the Ring*....
> - Did you finish it? He asked....
> - Yes. Get another of Paul de Kock's. Nice name he has.
> ...Reincarnation: that's the word.
> - Some people believe, he said, that we go on living in another body after death, that we lived before. They call it reincarnation. That we all lived before on the earth thousands of years ago or some other planet. They say we have forgotten it. Some say they remember their past lives.
>
> The sluggish cream wound curdling spirals through her tea. Better remind her of the word: metempsychosis. An example would be better. An example? ... He turned the pages back.
> - Metempsychosis, he said, is what the ancient Greeks called it.... What they called nymphs, for example.
>
> Her spoon ceased to stir up the sugar. She gazed straight before her, inhaling through her arched nostrils.
> - There's a smell of burn, she said. Did you leave anything on the fire?
> - The kidney! He cried suddenly (*U* 4.336-81).

Two levels of irony are seen in this passage. On the one hand, the example of metempsychosis with which Bloom attempts to enlighten Molly is suddenly cut short because Bloom burns the frying kidney, and she remains uninformed about the definition of the word. However, another example is right under her nose in her teacup. The cyclical nature of metempsychotic time is implied in the imagery of circles and spirals: "The sluggish cream wound curdling spirals through her tea".

The second level of irony is more complex, more abstract. A major feature of *Ulysses* is that Bloom repeats the wanderings of the ancient Greek Odysseus. Similarly, I argue that he anticipates the future epiphanies of the Jewish Einstein. The Greek/Jew oppositions in *Ulysses* take on added significance when we recognise this. Bloom shows that he is aware of the theory that would explain his resemblance to Odysseus and Einstein when he comments, "Some people believe ... that we go on living in another body after death, that we lived before". Ironically, however, Bloom never actually realises that he "lived before"; that he is repeating a past life, or that he may "go on living in another body" - that of Einstein.

Bloom's relationship with Einstein is reinforced by the vulgar nom-de-plume of Molly's favourite author: "Paul de Kock". This can interpreted as a sexual pun ("Paul de Kock" suggesting pulled the cock) or as an elaboration of Molly's pet name for Bloom ("Poldycock"). However, "Paul de Kock" also bears a striking resemblance to the name of Einstein's mother, "Pauline Koch", a name she kept even after marriage to Hermann Einstein, when she became Pauline Einstein-Koch (Pais 35). The name "Paul de Kock" is a further hint that Bloom could become Einstein by metempsychosis.

It is not just that Bloom anticipates Einstein; that anticipation itself accords with Einstein's theory of time. Four related theoretical constructs underpin the time organisation of *Ulysses*: the ancient Greek belief in "metempsychosis" and "the transmigration of souls" (*U* 4.341-2); Giambattista Vico's theory that time moves through a cycle of four stages culminating in a "thunderclap" (*U* 14.1379-90) and a recycling *ricorso*; the Hindu/Buddhist belief in reincarnation (*U* 12.344-55 and 8.1147); and Einstein's relativity theory of gravitationally curved space-time - the curving or warping of space or time in relation to gravity (*U* 17.2024-7).

Often in *Ulysses* these four non-linear time theories - Greek metempsychosis, Hindu/Buddhist reincarnation, Vico's *ricorso*, Einstein's gravitationally-curved space-time – merge indistinguishably into one another. We see this in "Cyclops", when Paddy Dignam's ghost returns from the netherworld:

> - Paddy Dignam dead! says Alf....
> - Dead! says Alf. He's no more dead than you are.
> - Maybe so, says Joe. They took the liberty of burying him this morning anyhow....
> - Good Christ! says Alf....
>
> In the darkness spirit hands were felt to flutter and when prayer by tantras had been directed to the proper quarter a faint but increasing luminosity of ruby light became gradually visible, the apparition of the etheric double being particularly lifelike owing to the discharge of jivic rays from the crown of the head and face. Communication was effected through the pituitary body and also by means of the orangefiery and scarlet rays emanating from the sacral region and solar plexus. Questioned by his earthname as to his whereabouts in the heavenworld he stated that he was now on the path of prãlãyã or return but was still submitted to trial at the hands of certain blood thirsty entities on the lower astral levels (*U* 12.321-47).

Blamires identifies the style of this passage as "the burlesqued idiom of pseudo-scientific spiritualist literature" (115), but we can be more precise than this. It is an amalgamation of Einsteinian time-theory and spiritualism. In *Geometry Relativity and the Fourth Dimension*, Rudolf Rucker, a mathematical physicist, makes this statement:

> The early part of our century marked a high point in the popular interest in the four dimensions. Spiritualism, with its 4-D spirits was all the rage, and the Einsteinian ... use of the fourth dimension [time] had given it a sort of legitimacy in the public mind" (32).

Dignam's ghostly return may be seen as a parody of the reincarnated metempsychotic soul from ancient Greek mythology, as the "Karma"[46] of Buddhism (*U* 8.1147) or the prãlãyã of Hinduism, as the familiar spirit of a necromancy session, or as a comic

[46] *Collins Cobuild English Language Dictionary* defines Karma as "the belief, in Buddhist religion, that your actions in one life affect all your other lives after that one" (Sinclair 790).

reenactment of Christ's resurrection ("Good Christ!"). The passage seems to poke fun at all these beliefs, especially at the claim that mediums can see auras – "etheric" "orangefiery and scarlet rays" in this case. But "orangefiery and scarlet rays," and "ruby light" "emanating from" the "solar" regions are also a feature of the theories of Einstein: specifically, Eddington's observation of red shifted light rays during the solar eclipse constituted observable proof of the curvature of time and abolished the old ether theory.

Stan Gibilisco explains the relationships between gravity, the slowing frequency of red shifted light rays, relativistic time dilation, and the curving of time and space:

> Gravitation causes time to move more slowly. This is true of any kind of *g* force. The greater the intensity of the force, the greater the time distortion. We see this effect when we observe the spectral lines of stars having extremely great density. The gravitational field at the surfaces of such stars is so great that the resulting time distortion causes a noticeable red shift. This has been observed by astronomers, lending support to the general theory of relativity....
>
> Gravitational fields actually cause a change in the shape of space, causing light to travel in a curved path instead of a straight line. The notion that light must always go in straight lines is no longer applicable; light always takes the shortest path it can, but if space is itself bent, it cannot possibly go straight (49).

Another place in *Ulysses* where Einsteinian time dilation and the curvature of space and time appear to be associated with red light is Joyce's "whirling" chapter: "Circe". The red light district of Dublin's brothel area, "Nighttown", is a place where time is as warped as the inhabitants. It is also where red light is found in abundance: "*the redcoats*", Carr and Compton, "*their tunics bloodbright in a lampglow*" (*U* 15.60-3), are red; there are "*red and green will-O'-the-wisps*", red "*danger signals*", the surrealistic "*coral and copper*" light (*U* 15.2-7) of the street lamps, the fiery "red glow" which lights the night sky in a "Big blaze" and which Bloom thinks might be an "*Aurora Borealis* or a steel foundry" (*U* 15.1-174); Bloom's refrain "London's burning, London's burning" (*U* 15.172) implies red: as does the "*dragon sandstrewer...its huge red headlight winking*"(*U* 15.185-6) that nearly runs down Bloom; and, Dublin's red light district itself has literary associations with the fires of Dante's Hell (*U* 15.4707). Significantly, "Circe" is the chapter that recycles the whole of the day's events in one gigantic time warp. Therefore it is not incidental that the action is based in, and bathed in, the red light of Dublin's brothel

area, since red shifted light is proof of the relativistic dilation of time and the curvature of space; as time slows and dilates, the wavelengths shift towards red.

Andrew Gibson identifies the non-linear dilation of time as a feature of the chapter, which "ruptures the experiences of the linearity of narrative time" so that "the dividing line between subjective and objective experiences of time is blurred" (19). The non-linear dilation of time can be clearly seen in the "Messianic Scene" where, between the actual events of Zoe's saying to Bloom "Go on. Make a stump speech out of it" (*U* 15.1353) and her follow-on comment "Talk away till you're black in the face" (*U* 15.1958), sixteen pages of text have intervened. Though Bloom and Zoe's dialogue probably occupies only a few moments, time dilates to allow the text to describe Bloom's election as "Lord mayor" (*U* 15.1364-1449), his coronation as "emperor-president and king-chairman...of this realm" (*U* 15.1472), his acknowledgement as "successor to" Parnell (*U* 15.1513) and constructor of "the new Bloomusalem" (*U* 15.1541-55), his assumption of the role of new Pope (*U* 15.1629), his denunciation as the Anti-Christ "from the roots of hell" by John Alexander Dowie (*U* 15.1754), his citation as "a finished example of the new womanly man" by Dr Punch Costello (*U* 15.1798), and his sending forth as a scapegoat by the court of inquisition (*U* 15.1898), with the result that he is finally declared guilty and burned at the stake as a "false Messiah" (*U* 15.1906). The sketch ends with Bloom's death: "Bloom becomes mute, shrunken, carbonised" (*U* 15.1995) which adds substance to Zoe's use of the word "black".

This dilation of time is entirely relative to the reference frame of the observer, mimicking Einstein's relativity theory. For the reader, time dilates and slows within the red light chapter, so that between Zoe's two closely linked interjections there is room for sixteen pages of text. However, for Bloom time is compressed and accelerates into a series of images culminating in his death by burning. Yet for Zoe, Bloom is momentarily stalling and wasting her time talking (and for her time is money).

Once, when Einstein was asked about "psychological time", he remarked: " When you spend two hours with a nice girl, you think it's only a minute. But when you sit on a hot stove for a minute you think it's two hours" (cited by Pickover 58). In "Circe's" "Messianic Scene", Bloom both spends time talking to an attractive girl, Zoe, and ends

up literally sitting on a hot stove – as he is burned at the stake. Thus, the slowing and acceleration of time mimics Einstein's observation on psychological time as well as his more august theory which relates dilating time to red light.

In the "Cyclops" and "Circe" passages all the references to red rays and red light might be a happy coincidence, were it not that at the end of "Nausicaa" Bloom seems to associate these same concepts with time theory as he falls into a Rip van Winkle type of sleep:

> Some light still. Red rays are longest. Roygbiv Vance taught us: red, orange, yellow, green, blue, indigo, violet. A star I see. Venus? Can't tell yet. Two. When three it's night. Were those nightclouds there all the time? Looks like a phantom ship....
>
> The year returns. History repeats itself.... Life, love, voyage round your own little world....
>
> So it returns. Think you're escaping and run into yourself. Longest way round is the shortest way home.... Circus horse walking in a ring. Rip van Winkle.... Then I did Rip van Winkle coming back.... Twenty years asleep in Sleepy Hollow....
>
> Metempsychosis. They believed you could be changed into a tree from grief.... Colours depend on the light you see.... Howth a while ago amethyst. Glass flashing. That's how the wise man what's his name with the burning glass.... a burning glass in the sun. Archimedes. I have it! My memory's not so bad (*U* 13: 1075-1142).

Bloom remembers that "red rays are longest" and associates this thought with two classic symbols of time dilation. The references to "nightclouds" and a "phantom ship" are allusions to the Flying Dutchman, whose doomed spirit was caught in a time warp, and who was destined to sail the storm-clouds aboard a ghost ship forever. He is elsewhere named "Vanderdecken" (*U* 15.1369) and the "phantom ship" is mentioned at *U* 15.1370. The other classical symbol of time dilation is Rip van Winkle, the character of Washington Irving's children's tale who "slept for twenty long years" and awoke to find himself living in another age (5).

Bloom's sleepy reverie parallels Rip van Winkle's long sleep, which is one of Joyce's many allusions to Vico's theory of *ricorso* - history moving through a recycled series of four stages. In *Ulysses,* Vico's name appears only twice: in "Nestor" - "Vico road, Dalkey" [*sic*](*U* 2.25) ; and in "Ithaca" - "Dr Tibble's Vi-Cocoa" (*U* 16:805-6). By

contrast, in *Finnegans Wake* (Giambattista) Vico's name is recycled everywhere; "a commodius vicus of recirculation" (*FW* 3.2-3), "Gambariste della Porca" (*FW* 9.35-6), and "grand old voice" (*FW* 132.27) are three representative examples. But Bloom's sleepy reverie goes beyond Vico to Einstein and Eddington; the reference to red light is associated with the curving of time. Bloom says "Some light still. Red rays are longest" and begins to think of the warping of time: " ... The year returns. History repeats itself". He is alluding to Einstein's general of theory of relativity, which as it happens, Brian writes - actually came to Einstein in a dream:

> Einstein began to confide ... admitting that the general theory of relativity came to him in a vision. After years of futile calculations, convinced that his quest was hopeless, he said he had gone to bed deeply depressed. Suddenly the answer appeared 'with infinite precision, and with its underlying unity of size, structure, distance, time, space, slowly falling into place piece by piece like a monolithic jigsaw puzzle'. Then, like a giant die making an indelible impress, a huge map of the universe outlined itself in one clear vision (159).

Further, in the passage from "Nausicaa", we notice the concept of "metempsychosis" or the recycling of souls: "So it returns. Think you're escaping and run into yourself". Metempsychosis is associated with cyclical patterns of time in the reference to the "Circus horse walking in a ring"- which is also a recycled reference to Molly's book, with just that hint of red light and curved surfaces in the title: "*Ruby: the Pride of the Ring*" (*U* 4.346) - "A novel about the atrocities of circus life" (Devlin 47). Significantly, the book first came up in the passage from "Calypso" (*U* 4.336-51) where Molly asked for the meaning of metempsychosis while stirring her tea. We are obviously dealing with circles within circles at this stage. Moreover, Bloom's idea, "So it returns. Think you're escaping and run into yourself" might also relate to Einstein, who postulated a "curved universe", so that when you started out on a journey through space you eventually ended up back at your starting point (Møller 360) – just like that other dreaming reverie, *Finnegans Wake*.

Yet another example of the book's recycling patterns is the reference to "Archimedes", the name Bloom failed to remember in relation to the first allusion to the *Gedankenexperiment* at *U* 5.39-52, where he was thinking about Newton's laws of gravitation as he dropped objects from O'Connell Bridge. Yet, he is actually wrong

again and his memory (as in the metempsychosis/metamorphosis mistake) is worse than he supposes. Archimedes discovered the law of displacement – an idea that accords with all the water imagery of "Nausicaa". Ironically, in fact, it was Newton who discovered the principle of the prism, the "burning glass in the sun" which splits light into the colours of the spectrum. Motz and Weaver make this clear:

> The second of Newton's great achievements was his experiments with light.... He ... experimented with prisms ... and observed that a ray of light passing through a prism is refracted ... in the familiar order of the rainbow: red, orange, yellow, green, blue, indigo and violet (47).

Bloom got the scientific details right when he recalled, "Red rays are longest. Roygbiv Vance taught us: red, orange, yellow, green, blue, indigo, violet", but he was wrong about the author of the original experiment. Moreover, Newton was not exactly the "wise man" Bloom supposes with this particular experiment, he repeatedly stared at the sun through the "burning glass" - and then went blind for three days, suffering retinal burns.

Bloom's failure to remember Newton's name and theoretical accomplishments is less interesting than his observation, "Longest way round is the shortest way home". In classical Euclidian geometry, involving flat surfaces, Bloom's observation is nonsense – the shortest distance between two points is a straight line. However, this is not so in the "non-Euclidean ... Reimann geometry" of "curved space-time" described by Einstein's "general theory of relativity" (Gribbin, *Companion* 103). Clifford Will illustrates the point when he writes that "Einstein postulated that the motion of a freely falling body, such as a thrown ball or an orbiting planet, was along a geodesic, a 'straight line' of the curved space-time" (35). Einstein made this point succinctly himself when his nine-year-old son, Eduard, asked him, "Why are you so famous?" Einstein replied, "When a blind beetle crawls over the surface of a globe, he doesn't notice that the track he has covered is curved. I was lucky enough to have spotted it" (Seelig 106). Similarly, Bloom almost notices that the path he has taken is curved in both space and time: "Life, love, voyage round your own little world.... So it returns.... Think you're escaping and run into yourself. Longest way round is the shortest way home". But, ultimately he doesn't spot it. He remains "a blind beetle"; epiphany is denied.

CONCLUDING REMARKS

In a letter to Harriet Weaver, Joyce explained the reason for the enlarged full stop at the end of "Ithaca": "Ithaca is... in reality the end", he wrote (*Letters* I 172). Suggesting that the large period not only ended Bloomsday, but also answered the final two questions of catechism: "When?" and "Where?" (*U* 17.2328-32). The implication is that the enlarged full stop both finishes the text and pinpoints the exact temporal-spatial location of Bloom at the end of a long and busy Bloomsday. The two questions are answered in terms of Newton's three laws of motion - Bloom is at absolute rest: "In what state of motion or rest?", at rest, ".".

With respect to these last two questions concerning temporal-spatial location, however, C. H. Peake stresses the indeterminacy of Bloom's final state of rest or motion:

> 'Where?'.... [and] the next question 'When?' is itself hardly intelligible (does it mean when did he rest or when did he travel?), and provokes not an answer but an incoherent response: 'Going to a dark bed there was a square round Sinbad the Sailor roc's auk's egg in the night of the bed...' (296).

Peake argues that Bloom can hardly be going to a dark bed and already in bed. In a Newtonian sense, he is correct. However, indeterminacy of time events is a central feature of the relativity theories, and absolute declarations about events are only possible when all observers are simultaneously at rest. Einstein wrote in 1905: "So we see we cannot attach any absolute signification to the concept of simultaneity, but that two events which, viewed from a system of co-ordinates, are simultaneous, can no longer be looked upon as simultaneous events when envisaged from a system which is in motion relatively to that system" ("On the Electrodynamics of Moving Bodies" 42). Therefore, according to Einstein, declarations about when things happen are entirely dependent on the observer's frame of reference, especially whether it is in relative motion or at rest.

The slightly earlier description of Bloom and Molly's final state of rest on their bed gives a relativistic twist to Peake's Newtonian interpretation:

> In what state of rest or motion?
>
> At rest relatively to themselves and to each other. In motion being each and both carried westward, forward and rereward respectively, by the proper perpetual motion of the earth through everchanging tracks of neverchanging space (*U* 17.2306-10).

At one level, Joyce is using relativity theory to make a Homeric gag against Bloom. Odysseus' bed was constructed into the sides of "a strong young olive tree...the trunk as thick as a pillar", and was completely immovable, while Bloomstein's bed is in perpetual relative motion (Homer 256). However, the fact that Bloomsday ends with Bloom "at rest" may also relate to Michelson and Morley's null hypothesis concerning the ether theory which Bloom quoted *verbatim* at *U* 17.262-3. Michelson and Morley encountered an experimental failure in trying to prove the existence of Newton's theory of absolute space, that part of Newton's mechanical universe that was hypothesized to be in a state of absolute rest. This passage also suggests that Bloom's final state of rest be qualified by concepts straight out of the 1905 special theory of relativity - Einstein's relative motion postulate, which Gibilisco summarizes thus:

> Our universe has millions of objects. They are all moving with respect to each other in an infinite combination of velocities. Finding any one object to call "at rest" is simultaneously trivial and impossible. Every object is, of course, stationary with respect to its own reference frame and in motion relative to most other objects. Relativity theory asserts that every point of view is as good as any other; there is no absolute [Newtonian] standard of motion in the universe (4).

In the description of Molly and Bloom "at rest relatively to themselves and to each other" we see exactly the same tension between Newtonian "rest" and Einsteinian relative "motion".

Yet, this relatively restful ending to Bloomsday also has its own puzzle. In Newtonian absolutist terms, the earth is rotating to the east relative to the sun, not the "westward" reverse as suggested above in "Ithaca". It could be argued that Joyce simply made a mistake about the earth's rotational direction. However, earlier in "Wandering Rocks" we saw a reversal of direction; at *U* 10.753, the "crumpled paper ball" was

floating "westward" instead of the expected "eastward" dictated by the Liffey's flow (*U* 10.296, 1096). Hannay explained this reversal by applying Einstein's relative motion postulate and changing the reference frame. This same principle applies to the passage in "Ithaca". In terms of relative motion the narrator (or textual Arranger) has, for reasons which admittedly remain obscure, a frame of reference which is moving in the opposite easterly direction to Molly and Bloom, so that they appear to be moving westwards. This means that at the ending of "Ithaca" nobody has any privileged status of absolute rest: not Bloom, not Molly, not the earth, not the text, and certainly not the narrator. The strange motion of the Arranger explains the indeterminacy of Bloom's temporal-spatial location. The final full stop thus becomes a rotating ball; the full stop of absolute rest is denied!

Full stops, enlarged or otherwise, are certainly in short supply in Molly's ensuing soliloquy, although, as Jennifer Wicke puns, "Molly ... [is] the plump period which marks the domestic spot..." (181). "Penelope" then confirms the relativistic culmination of Bloom's quest suggested by "Ithaca". With respect to closure, this novel completely disrupts the smooth linear flow of Newtonian time and its associated beginning, middle and end. The reader is actually confronted with two textual endings (and two versions of Bloom going to bed), just as the novel has two beginnings in "Telemachus" and "Calypso". Margaret Mills Harper briefly hints at the tension between Einstein and Newton with respect to time in Joyce's final chapter when she states:

> The discourse of "Penelope" strips away the story of *Ulysses* ... by a seeming retreat from diegetical time into timeless revery [*sic*].... An examination of time ... reveals that temporal dimensionality is also relative, both in itself and with regard to space, in an Einsteinian manner: how quickly time passes, where objects or people might be situated in it ... and whether it moves forward from past to present to future [i.e. Newtonian time theory] are all debatable issues (252-3).

Harper is correct. On the one hand, the final chapter's abandonment of punctuation emphasises the uninterrupted flow of Molly's interior monologue. The flow of Newtonian absolute time is also emphasised in other ways. The bells of St George's toll the quarter hours, thus indicating that the whole monologue takes place between a little before 2am (*U* 18.1231) and a little after 2:15am (*U* 18.1540). As Harriet Blodgett comments, "Temporally, it is the shortest episode in the book" (26).

On the other hand, it is plain that Joyce wished to disrupt the notion that "Penelope" can be located at some point in chronometrical time, because the *Linati Schema* accords the chapter an eternity symbol, "∞", which is quite different from the timekeeping marked by the bells of St George's. In another letter to Weaver, Joyce located the chapter even further outside human time experience when he wrote, concerning "Penelope": "In conception and technique I tried to depict the earth which is prehuman and presumably posthuman" (*Letters* 1, 180). Again, in a notorious comment to Budgen about his last chapter, Joyce further emphasised the circularity of time in this episode:

> *Penelope* is the clou of the book.... It begins and ends with the female word *yes*. It turns like the huge earthball slowly surely and evenly round and round spinning, its four cardinal points being the female breasts, arse, womb and cunt ... *woman, yes* (*Letters* 1:170).

That end, both textual and anatomical, seems to hold yet one more surprise: the element of relativity. Wicke argues that Molly's thoughts are "literally transmigratory" (181) as she traverses different sexual events and amalgamates three different persons, times and places: "Mulvey [in Gilbraltar] in 1886 and with Bloom [on Howth Head 16 years ago] in 1888" (Raleigh 10), and herself and Boylan now in 1904. Many critics have used the ending to highlight Molly's wantonness; others stress her fertility, her femaleness and/or her generativity associated with the Earth-mother "Gea-Tellus" (*U* 17.2313). However, I believe what is stressed is Molly's fall.[47] For Joyce, the concept of falling has been associated with the 32 feet per second per second acceleration of gravitation, coupled with all sorts of ideological, scientific, and theological overtones relating to the fallen Eve, the fall of Newton's apple and, of course, Einstein's free fall *Gedankenexperiment*, which we saw translated into the actual fall - at 32 feet per second per second - of Bloom's body as he fell in love with Molly on Howth Head.

[47] Molly's Eve-like fall is suggested by her adulterous consumption of "Plumtree's Potted Meat", which represents Eve's fall through eating the forbidden fruit of the tree of knowledge of good and evil. The forbidden tree was traditionally thought to be an apple tree. Blazes Boylan is, of course, like the bright and shining Lucifer. Parts of him are also very snake-like as he offers the food to Molly. Molly invites us to associate "Plumtree's Potted Meat" with the apple tree and its forbidden fruit at *U* 18. 1534-5: "You wouldn't know which to laugh or cry were such a mixture of plum and apple". Molly, therefore, implies that she, like post-lapsarian fallen Eve, is a mixture of good and evil, plum[tree] and apple.

In this thesis I have emphasised that the 32 feet per second per second free fall *Gedankenexperiment* was the happy moment of epiphany for Einstein, which propelled him onwards to the general theory of relativity: a new theory of gravitation which accounts for the real source of gravity as the mass-curvature of space-time. The curved geometry of space and time was described mathematically in the theory and was later proven by Eddington's observations during an eclipse. Gravity was not some vague instantaneously transmitted force as Newton had supposed.

If we accept that Joyce was conscious of the *Gedankenexperiment* which led Einstein to a new theory of gravitation, it should not surprise us that Molly herself fell *gravid* - pregnant with Milly - as a result of falling in love with Bloom on top of Howth Head. Molly fell in love with Bloom on 10 September 1888[48] (*U* 17.2278) and Milly was born 9 months later on 15 June 1889 (*U* 17. 2271-7). Nor should it surprise us that Molly is aged 32[49] - "Ill be 33 in September" (*U* 18.475) - on Bloomsday, nor that the fall-in-love scene happened in another leap-year "16 years ago" (*U* 18.1575) - 16 being half of 32, a factor which gives extra significance to the fact that the novel is set on 16 June 1904. Clearly, the number 32 - and its factors - are as important in *Ulysses* as in *Finnegans Wake*.

What are all those 32s doing in the texts? The general theory of relativity asserts that gravitation warps time. All the references to gravitation and falling at 32 feet per second per second are related to bending, warping and curving of time - so that in the *Wake* the ending of the text curves right back to its beginning. Likewise, *Ulysses* is a highly complex transitional text where Joyce progressively abandoned Newtonian linear time for Einsteinian relative time, with Bloom as the agent of change.

But if Bloom really is a metempsychotic anticipation of the greatest Jewish scientist of the 20th century - Albert Einstein - as well as a metempsychotic reincarnation of the ancient Greek hero Odysseus, he goes to bed none the wiser. He is - as the critics realise

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[48] 1888 is also a factor of 32: 32x59=1888.

[49] Blamires, however, argues that Molly underestimates her own age by a year: "she will be thirty-four, not thirty-three, in September" (230). Yet, Joyce has done this deliberately - so Molly, at least, believes she is 32 on Bloomsday.

- blissfully unaware that he has just repeated the 20-year wanderings of Odysseus and - hardly surprisingly - he is completely unaware that he has anticipated the insights of Einstein and Eddington. Locked in the troubles of the present, Bloom is unable to see his own relationships to the past or to the future; epiphany is denied.

EPILOGUE

Time magazine, on 8 June 1998, identified James Joyce as the greatest novelist of the 20th century and *Ulysses* as the greatest work of fiction (Gray 63-5). On 29 March 1999, the same magazine named Albert Einstein as the greatest scientist of the 20th century (Gleick 43-6), and his special and general theories are considered as the "greatest achievements in the human history of thought" (Will 11). Bloom straddles both entries and yet was not recognised by *Time*; greatness denied (as it was by the newsmen in "Aeolus" - and almost everybody else - in *Ulysses*).

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