Editor's Preface

This volume contains new publications of A. S. Eddington's famous book *Space, Time and Gravitation: An Outline of the General Relativity Theory* [1], written for a wider audience, and two short pieces originally published in *Nature* – an article on time (The Relativity of Time [2]) and a Letter to the Editor on space ("Space" or "Aether"? [3]). The short *Nature* publications are included in the volume because they shed additional (and still important today) light on some aspects of the (then) new views of space, time and gravitation.

The volume begins with an excellent Foreword by Dennis Dieks which will be found very informative not only by the general readers but also by physicists and philosophers.

Two things justify the new publication of Eddington's book, which was published in 1920, only four years after the publication of Einstein's general relativity.

1. Eddington is well-known, not only in his day, as a committed and very successful popularizer of science. This is true particularly for Einstein's general relativity because in 1918 Eddington gave its first systematic exposition *Report on the Relativity Theory of Gravitation* [4] and was instantly recognized as one of the most trusted experts in this new and difficult field. Eddington's mastery in writing clearly about challenging and abstract concepts, in full display even in this technical treatise, is the reason why his books are still valuable today. Here is what the renowned astrophysicist Subrahmanyan Chandrasekhar, who received the 1983 Nobel Prize for Physics, wrote in 1983 [5]:

> Eddington's *Report* is written so clearly and yet so concisely that it can be read, even today, as a good introductory text by a beginning student.

Two years later (in 1920) Eddington published *Space, Time and Gravitation: An Outline of the General Relativity Theory* specifically written for non-experts to explain the new and revolutionary ideas about space, time and gravitation. The following year – in 1921 – in a review in the *Bulletin of the American Mathematical Society* Edwin Bidwell Wilson wrote that Eddington's book "is undoubtedly the best general presentation" of general relativity [6]. This view was further strengthened in 1923 when Eddington published his comprehensive treatise on the mathematical and physical foundations of general relativity *The Mathematical Theory of Relativity* [7] because it demonstrated to everyone that the popular book *Space, Time and Gravitation* is written not only by a skilled popularizer of science but also by one of the three (as the legend has it) experts on general relativity.

2. What justifies the new publication not only of Eddington's *Space, Time and Gravitation* but also of his *Nature* pieces are Eddington's views on some fundamental issues that have not yet been resolved. Here are several examples:

2.1. In 2018 we will mark the 110th anniversary of Hermann Minkowski's groundbreaking lecture "Space and Time" [8] in which he presented Eisnstein's special relativity as a theory of flat spacetime (Minkowski called it "die *Welt*" or the [four-dimensional] World), but there is still no consensus among physicists

and philosophers on the issue of the reality of spacetime. In the distant 1920 and 1921 Eddington directly confronted this issue:

> The question is often raised whether this four-dimensional space-time is real, or merely a mathematical construction; perhaps it is sufficient to reply that it can at any rate not be less real than the fictitious space and time which it supplants. ["The Relativity of Time," in this volume p. 160]

> However successful the theory of a four-dimensional world may be, it is difficult to ignore a voice inside us which whispers "At the back of your mind, you know that a fourth dimension is all nonsense." I fancy that that voice must often have had a busy time in the past history of physics. What nonsense to say that this solid table on which I am writing is a collection of electrons moving with prodigious speeds in empty spaces, which relatively to electronic dimensions are as wide as the spaces between the planets in the solar system! What nonsense to say that the thin air is trying to crush my body with a load of 14 lbs. to the square inch! What nonsense that the star-cluster, which I see through the telescope obviously there now, is a glimpse into a past age 50,000 years ago! Let us not be beguiled by this voice. It is discredited. [*Space, Time and Gravitation*, in this volume p. 41]

> In a perfectly determinate scheme the past and future may be regarded as lying mapped out—as much available to present exploration as the distant parts of space. Events do not happen; they are just there, and we come across them. [*Space, Time and Gravitation*, in this volume p. 37]

2.2. The issue of the nature of relativistic length contraction (of a rod) has been debated for years (even recently), whereas Eddington clearly argued in favour of Minkowski's explanation of length contraction [8, p. 116] – that the spaces of two observers in relative motion intersect the rod's four-dimensional worldtube at different angles and the resulting cross-sections are of different length; the cross-section of the rod's worldtube for the observer, with respect to whom the rod moves, is shorter. Eddington's position on the nature of length contraction is unambiguously stated:

> The real rod in nature is the four-dimensional object shown in section as $P'PQQ'$. [*Space, Time and Gravitation*, in this volume p. 40]

2.3. The issue of whether relativity got rid of the ether has also been debated for years. In his Letter to the Editor of *Nature* "Space" or "Aether"? Eddington insisted that space is not emptiness (one may argue that, logically, emptiness implies non-existence), but is something that is not three-dimensional and in order to be consistent with general relativity "it is called by Minkowski's term *world*" (in this volume p. 164).

2.4. In his *Nature* article "The Relativity of Time" Eddington makes a bold statement – "gravitation as a separate agency becomes unnecessary" (in this

volume p. 161) – which may be interpreted in a sense that gravitation is not a physical interaction since all gravitational phenomena may be fully explained as manifestations of the non-Euclidean geometry of spacetime. Such a stunning interpretation may offer an explanation of the unsuccessful attempts to create a theory of quantum gravity, which does not appear to have been examined so far.

Montreal, 24 August 2017

Vesselin Petkov
Minkowski Institute

References

1. A. S. Eddington, *Space, Time and Gravitation: An Outline of the General Relativity Theory* (Cambridge University Press 1920)

2. A. S. Eddington, The Relativity of Time, *Nature* **106**, 802-804 (17 February 1921)

3. A. S. Eddington, "Space" or "Aether"? *Nature* **107**, 201 (April 14, 1921)

4. A. S. Eddington, *Report on the Relativity Theory of Gravitation* (Fleetway Press, London 1918); new publication: A. S. Eddington, *Report on the Relativity Theory of Gravitation* (Minkowski Institute Press, Montreal 2014)

5. S. Chandrasekhar, *Eddington – The most distinguished astrophysicist of his time* (Cambridge University Press, Cambridge 1983), p. 24

6. E. B. Wilson, Review: A. S. Eddington, Space, Time and Gravitation; an Outline of the General Relativity Theory, *Bull. Amer. Math. Soc.*, Volume 27, Number 4 (1921), 182-186

7. A. S. Eddington, *The Mathematical Theory of Relativity* (Cambridge University Press, 1923); new publication: A. S. Eddington, *The Mathematical Theory of Relativity* (Minkowski Institute Press, Montreal 2016)

8. H. Minkowski, Space and Time. In: H. Minkowski, *Space and Time: Minkowski's papers on relativity* (Minkowski Institute Press, Montreal 2012)