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Helge Kragh

Varying Gravity

Dirac's Legacy in Cosmology and Geophysics

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Preface

The reader will find here a historical investigation of a particular episode in the history of twentieth-century science which principally involves an unorthodox cosmological theory concerning the history of the universe and a no less unorthodox geological theory concerning the history of the Earth. By its very nature, the subject under examination, various early attempts of integrating cosmology and geophysics, is highly interdisciplinary. When Paul Dirac proposed that the gravitational constant decreases over cosmic time, a proposal which dates from the late 1930s, no one thought it would have consequences for geophysics. Nor did anyone think that the Earth might eventually be a testing ground for Dirac's hypothesis. After all, the domain and methods of geophysics were (and still are) very different from those of physical cosmology and at the time the two communities of scientists were entirely separate. As it happened, the audacious gravitation hypothesis was first applied to paleoclimatology in the late 1940s and about a decade later it entered geophysics as an argument for the expanding Earth.

The idea that the Earth has increased in size for at least 500 million years was at the time a fairly popular alternative to the resuscitated theory of continental drift that would soon be merged with mantle convection and sea floor spreading to develop into mainstream plate tectonics. The chief focus of the book is on the interconnection between the two hypotheses, but it also covers in some detail other aspects of varying gravity and the expanding Earth. The subjects gave rise to a considerable literature in physics, astronomy, cosmology, geology and geophysics, much of it of an interdisciplinary nature. Altogether several hundred scientific articles and a few books have been published on these subjects. However, from today's perspective, the efforts were wasted and may seem to have been just much ado about nothing. The currently established view is that the force of gravity, as given by the gravitational constant G , remains constant and that the radius of the Earth has not increased measurably since its formation some 4.5 billion years ago. In spite of this consensus view, there are still scientists cultivating either the varying-gravity hypothesis or the expanding Earth hypothesis—or, in a few cases,

both hypotheses. But I largely keep to the historical ground, meaning the period up to about 1980, and only briefly refer to the modern scene.

I came to this subject initially as a result of my earlier studies of Dirac's physical theories and my work on the history of modern cosmology generally. Only at a later stage did I develop an interest in the history of the earth sciences in connection with courses in the history and philosophy of science given to undergraduate geology students at Aarhus University, Denmark. It was only then that I realized how relatively important the varying-gravity hypothesis and expanding Earth models were in the 1960s and 1970s. I recently published a couple of papers on the subject, one in *Physics in Perspective* and another in *History of Geo- and Space Sciences* (see the Bibliography). This book makes use of material from these papers but goes much beyond them. I should also mention that I am not the first to cover the subject. Paul Wesson examined it from a different and more scientific perspective in two valuable books dating from 1978 to 1980. However, Wesson primarily addressed his work to scientists and therefore paid little attention to the rich historical context of his subject.

The book is organized into four chapters of which the first one is rather brief and of an introductory nature, dealing essentially with developments before 1930. Chapter 2 investigates in detail the idea of varying gravity from a cosmological and physical perspective, starting with Dirac in 1937 and ending with the Jordan–Brans–Dicke gravitation theories of the early 1960s. While geophysics plays almost no role at all in this chapter, the expanding Earth is in the centre of Chap. 3 which deals in particular with theories that applied varying gravity as a mechanism for the assumed expansion of the Earth. The fourth chapter carries the story on until the early 1980s, at a time when varying-gravity hypotheses had proliferated but the expanding Earth hypothesis no longer enjoyed recognition from mainstream geophysicists. Although the approach of the book is neither biographical nor prosopographical, of course there are some scientists who appear more frequently than others. They include well-known physicists such as Paul Dirac, Pascual Jordan and Robert Dicke as well as the less well-known Hungarian geophysicist László Egyed. *Varying Gravity* ends with a rather lengthy bibliography which we hope can be useful to historians and scientists who might wish to explore further aspects of this case study.

Copenhagen, Denmark
August 2015

Helge Kragh

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