Vincent Icke

GRAVITY DOES NOT EXIST

A Puzzle for the 21st Century

Amsterdam University Press

Cover design and lay-out: Gijs Mathijs Ontwerpers, Amsterdam
Illustrations: Vincent Icke

ISBN 978 90 8964 446 6
e-ISBN 978 90 4851 704 6 (pdf)
e-ISBN 978 90 4851 705 3 (ePub)
NUR 924

Contents

Foreword

This is a Small Book about a Big Question, not a textbook of known physics. Or perhaps it's about a Big Opinion — or a small opinion, depending on one's perspective. It's a book about unknown physics. Every scientific fact was born as an opinion about the unknown, often called a 'hypothesis'. Opinion gradually becomes fact when evidence piles up. By perceptive and diligent work, it is

> ***… possible to attain a degree of probability that quite often is hardly less than complete certainty. Namely, when the things that one has deduced from the supposed principles correspond perfectly to the phenomena that observations show us,***

as Huygens wrote. It has been so ever since, except that instead of 'supposed principles' we now say 'theory'. But what if there are *two* theories, each of which has produced a myriad of 'things that correspond perfectly to the phenomena' but that cannot be combined? One theory replaced the mystery of gravity by a precise picture of space and time. The other replaced the mystery of matter by a description of quantum particles that is so exact that some of its predictions have been verified to eleven decimal places. At the present time in our Universe, we may keep these two separate, each in its own domain: space and time for very large things, particles for the world of the very small. However, 13.8 billion years ago, these two incompatible theories referred to a single realm. Many scientists think that they can be united only by a minuscule group of hyper-specialists. I think differently. The mathematics of the ultimate answer will be as arcane as always, but that formulation will have to follow upon some original perception. Insight is freely distributed; all you've got to do is pick it up. I hope that somewhere a girl or boy will do so, because the generations of physicists who made the existing brilliant theories will soon be extinct. We will never understand the beginnings of our Universe until this puzzle has been cracked. That is why I hold the opinion that this is not just a big question, but the Biggest Question in physics of the 21st century.

The Process of Measurement

With measured tread, Johan Cornets de Groot climbed the many steps to the first tier of the tower. He did so solemnly, as seemed proper for his rank as burgomaster of Delft in southern Holland. De Groot had been invited to witness a physics experiment proposed by Stevin,[1] the Flemish engineer, polymath and private physics instructor to Maurits, Prince of Orange.

This is the way it happened in my imagination. What these two men actually did has not been recorded, except for the setup and outcome of their experiment. The year was 1585, in an era when the scientific acceptance of observations and experimental evidence was beginning to grow in the minds of the intelligentsia (the illiterate stonemason and the shipwright had always respected facts, of course). In our 21st century, surrounded at all times and in all places by the products of science, it is difficult to appreciate how radically new it was to conduct an experiment that brushed aside nineteen centuries of philosophical opinion and, indeed, to devise such a test in the first place.

High above the ground, the experimental apparatus was held ready: two leaden balls, one ten times heavier than the other, prepared by Simon Stevin of Brugghe. He was a scientist in the best modern sense of the word: his brain held a vast amount of knowledge; he was familiar with all the classical works on physics and mathematics known in his time; his own work advanced science and engineering; and he informed non-scientists about the wonders of the world — among them Maurits, Prince of Orange, for whom he composed a fat compendium of theoretical and practical physics and mathematics entitled *Wisconstige gedachtenissen* (Flemish for something between 'mathematical musings' and 'mathematical inventions').[2]

1 Simon Stevin (1548-1620), Flemish scientist.

2 Simon Stevin, *Wisconstige gedachtenissen*, Jan Bouwensz., Leiden 1608.

Stevin knew a lot, but he also understood that science is not so much about knowing as it is about searching. Of course it is necessary to be aware of the state of knowledge, but mostly to determine one's point of departure on a voyage into *terra incognita*, and possibly to get some idea about what direction to take in that immeasurable land. Like Galileo, Huygens, Newton[3] and others, Stevin was one of the founding fathers of science, known as 'natural philosophy' at the time. The trade was sometimes also called 'experimental philosophy', and that is the expression I prefer to use because of its nice sharp taste of active research.

In *De Weeghdaet* (literally meaning 'The Act of Weighing' but the implication is 'The Process of Measurement'), one of the chapters of *Wisconstige gedachtenissen*, Stevin reports on the experiment he conducted on that tower in Delft: dropping two leaden balls at the same time, one ten times heavier than the other, in order to see if — as Aristotle[4] had insisted nineteen centuries before — the more massive one would arrive first at the foot of the tower.

This experiment is almost always attributed to Galileo, but there is only anecdotal evidence[5] that he performed it, and then not before 1590. In any case, he did not publish his results; this is significant, because Galileo was always ready and eager to tell the world about his discoveries. In his writings, he merely describes a thought experiment, wondering what would happen if a light and a heavy stone were connected by a nearly weightless thread.

→ The Oude Kerk in Delft in 2014, silhouetted against a Hubble Space Telescope image of the interstellar nebula NGC602. The tower is leaning a little. It is thought that Stevin conducted his lead-ball experiment here. The precise spot is unclear; it may even have been inside the church, where several suitable locations also exist.

3 Galileo Galilei (1564-1642), Christiaan Huygens (1629-1695), Isaac Newton (1643-1727); Italian, Dutch, English scientists, respectively.

4 Aristoteles of Stagirus (384-322), Greek philosopher.

5 Michele Camerota, *Galileo Galilei e la cultura scientifica nell'età della controriforma*, Salerno Ed., Roma 2004, pp. 61-63.

In fact, Stevin's procedure was much more subtle than is reported in the tales about Galileo on the Leaning Tower of Pisa. To begin with, the release of the balls was witnessed by an independent observer who, given his social status, could not afford to endanger his reputation for being just and impartial. Furthermore, how would one determine whether or not the two balls arrive on the ground at the same time? No equipment existed to measure the time of the fall, and, after a drop of at least ten metres, the balls would be moving far too quickly to allow a determination by eye. Stevin placed a wooden board at the foot of the tower, put one of his aides next to it with his back turned towards the board, and merely asked him to tell whether he heard one thump or two. The servant reported

> ***… that together they impact the board so equally, that their separate sounds appear to be a single blow.***

Simply brilliant — which one of Stevin's contemporaries would have invented such a robust elegance?

It was a dramatic result, because Aristotle and his followers had always stated that objects fall more quickly if they are heavier. It's dramatic, because this type of *experimental* philosophy was based on the principle that fact takes precedence over opinion and authority, a principle that has enlightened the world ever since.[6] Before that time, the opinions of scholars soared high above the practical facts of mere craftspeople and engineers: if a philosophical dictum did not match a test, then so much the worse for the test.

Even today, Stevin's observation is a dramatic result, because it is a matter of life or death. In the summer of 2009, a man jumped into the Niagara River and let himself be carried over the falls, hoping to end

6 Later experimenters, even more subtle than Stevin, have performed a variety of increasingly precise tests in order to see whether the acceleration due to gravity depends on an object's mass, composition, or other properties: Eötvös, Dicke, Braginskij and others all found that the answer is no. Some of these experimental results are accurate to twelve or thirteen decimal places.

his life. He survived, however, wet but unscathed. Just as in Stevin's experiment, the water in the river dropped with the same acceleration as the man. When he arrived at the foot of the falls, he was surrounded by tons of water travelling with the same speed as he did, protecting him so well that he lived to tell the tale. Had he jumped down beyond the falls, he would have fallen 56 metres to hit the river at about 100 kilometres per hour. At that speed, water doesn't feel much softer than rock. Saved by Simon, one might say…

Stevin performed his experiment four-and-a-quarter centuries ago. In what follows, I will trace the various explanations that have been given for the dramatic fall that '*appear*[ed] *to be a single blow*' in the course of more than four centuries. In the process, we will pass a series of historical milestones that mark the road to the present state of physics.[7]

History does not end today, and Stevin's finding is still highly enigmatic. This is due to the discovery that lead is made of atoms, and that these atoms are made of yet smaller particles. I will sketch the relevant aspects of particle behaviour that are engraved on yet more milestones, beginning where the previous series ended.[8]

Having followed that road to the place where we stand today, we will see that two monumental achievements in theoretical physics, namely general relativity and quantum field theory, are in dramatic conflict with each other. This conflict may be cast in the form of the most important physics question of our time. For the moment, that question may be phrased as: *How does the Sun produce the curvature of its surrounding space-time?*

7 Kepler's *Harmonices Mundi* (1619), Galileo's *Dialogo* (1632) and *Discorsi* (1638), Huygens's relativity theory in *De Vi Centrifuga* (written in 1659, published posthumously in 1703) and *Horologium Oscillatorium* (1657), Newton's *Principia* (1687) and Einstein's *General Theory of Relativity* (1916).

8 Schrödinger (1926), Feynman (1948), Yang & Mills (1954), Englert & Brout (1964), and the recent discoveries at CERN's Large Hadron Collider (2012).