Planck – Public Event

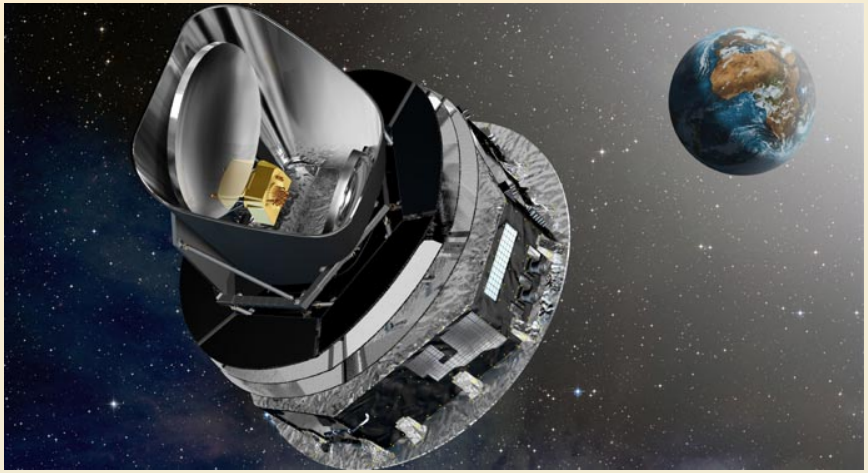
Chair: Malcolm Longair: University of Cambridge

Graça Rocha: JPL, CalTech. Member of Planck Consortium

Bruce Partridge: Haverford College, USA, Member of Planck Consortium.

Planck and the Role of Precise Observation

Tycho Brahe c.1600



Planck 2013

Precise experiment and observation are at the heart of all the great discoveries of modern science.

Tycho Brahe and the Newtonian Revolution

Tycho Brahe was inspired to begin his great series of observations of the stars and planets by the inaccuracies in the Alphonsine Tables. With the sponsorship of Frederick II of Denmark, he constructed his great observatory on the island of Hven. The instruments were the most advanced available, resulting in an improvement in accuracy of a factor of 10 over previous measurements.

Johannes Kepler and the Newtonian Revolution

‘Divine Providence granted to us such a diligent observer in Tycho Brahe that his observations convicted this Ptolemaic calculation of an error of 8 minutes of arc; it is only right that we should accept God's gift with a grateful mind ... Because these 8 minutes of arc could not be ignored, they alone have led to a total reformation of astronomy.’

- Equal areas are swept out by the line from the Sun to a planet in equal times (Kepler 2, 1603).
- The planetary orbits are ellipses with the Sun in one focus (Kepler 1, 1609).
- The period of a planetary orbit is proportional to the three-halves power of the mean distance of the planet from the Sun (Kepler 3, 1618).

Kepler’s three great laws of planetary motion led directly to Newton’s laws of motion, the foundation of classical physics.

James Clerk Maxwell & Precise Measurement

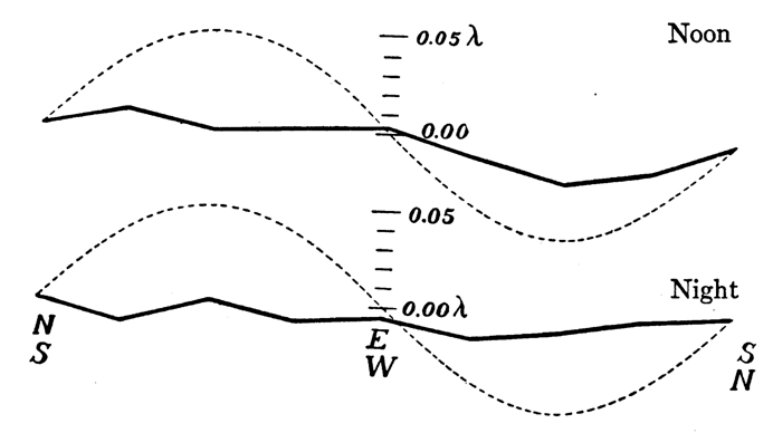
James Clerk Maxwell delivered his inaugural lecture as the first Cavendish Professor of Experimental Physics on 25 October 1871.

- ‘The characteristics of modern experiments - that they consist principally of measurements - is so prominent, that the opinion seems to have got abroad, that in a few years all the great physical constants will have been approximately estimated, and that the only occupation which will be left to men of science will be to carry on these measurements to another place of decimals.’

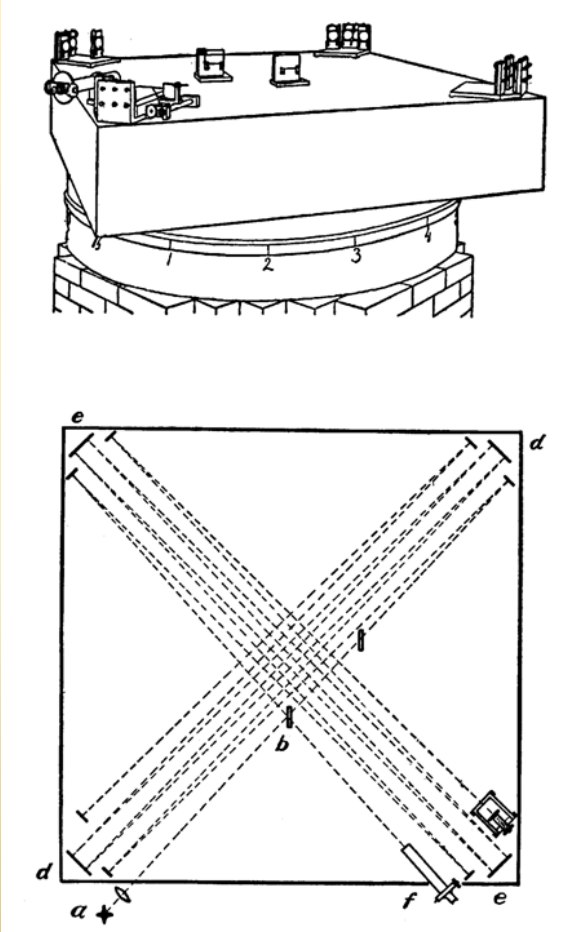
- ‘But the history of science shews that even during that phase of her progress in which she devotes herself to improving the accuracy of the numerical measurement of quantities with which she has long been familiar, she is preparing the materials for the subjugation of new regions, which would have remained unknown if she had contented with the rough guide of the earlier pioneers.'

The Michelson-Morley Experiment

By 1887, Michelson had perfected his measurements of the speed of the Earth through the hypothetical aether.



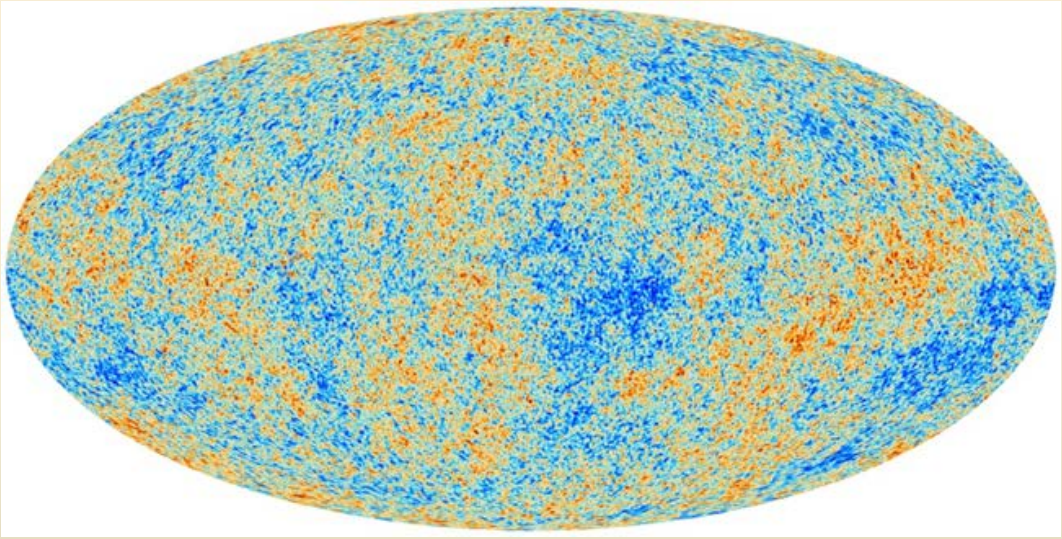
The broken line shows one eighth of the expected variation if the Earth moves through the stationary aether.



The null result of these precise measurements led directly to the special theory of relativity.

The Role of Precise Observation

The moral of these examples is that fundamental discoveries come from precise measurements and observations. The rule of thumb I use is that every factor of ten improvement in precision and accuracy results in new insights into the workings of our Universe.



This is what Planck offers us in tackling the great problems of cosmology.