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Outcome of the Royal Society meeting on *G* held at Chicheley Hall on 27 and 28 February 2014 to discuss 'The Newtonian constant of gravitation, a constant too difficult to measure?'

Terry Quinn

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Discussion

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One contribution of 13 to a Theo Murphy Meeting Issue 'The Newtonian constant of gravitation, a constant too difficult to measure?'

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Outcome of the Royal Society meeting on *G* held at Chicheley Hall on 27 and 28 February 2014 to discuss 'The Newtonian constant of gravitation, a constant too difficult to measure?'

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At the end of the meeting, a broad consensus was reached on the following main points.

(1) The problem of arriving at a reliable value for *G* in the face of the wide dispersion of recent results (some 450 ppm, more than ten times the sigma of the individual results) is unlikely to be resolved by one or two additional results obtained, as in the past, by teams working independently.
(2) There is nevertheless an urgent need to resolve this situation, unprecedented in the determination of one of the fundamental constants of physics. Although at present there is no pressing problem in theoretical physics that requires an accurate value of *G*, accurate values of the fundamental constants are an essential part of the foundations of physics. In almost all areas of the physical sciences, determinations of fundamental constants are at the frontiers of science. This is so in experimental gravitational physics where one of the characteristics of the work is the need to measure extremely small forces. The science and techniques used in the determination of *G* are those also used in tests of the equivalence principle, in tests of the inverse square law and in the search for other non-Newtonian forces. Quite apart from the results of such measurements, whether they are null experiments or ones leading to a value of a constant, the training of young scientists

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who participate has always been an important product of high metrology. The wide disagreement among recent measured values of G must cast some doubt on our abilities in this crucial area of small-force measurement and in other areas where similar techniques are used. This is an unsatisfactory situation.

(3) There are a number of key parameters some or all of which have to be measured with the highest accuracy in determinations of G. These include mass, density, length, time, electric current, voltage, capacitance and angle. In some experiments, there may be others. Measurements of these must be traceable to verified national and international standards with evaluated uncertainties with respect to the SI. The experiments themselves must be carried out in laboratories having the highest quality of temperature and environmental control. All of this strongly points to a national metrology institute, or a laboratory closely associated with a national metrology institute, as being the most appropriate place for future experiments to take place.

(4) Thus, instead of simply calling for new determinations of G, it is suggested that an international advisory board be created, made up largely of those who have already carried out a G experiment, to advise on the choice of method or methods, on the design of the experiment, on its construction and finally on the interpretation of the data and calculation of the results. This would be in contrast to the present situation in which outside criticism and comments can be brought to bear only when the experiment is finished and published when it is too late to affect the outcome. It is only by proceeding in this way that one might hope to obtain results that are demonstrably reliable.

(Text drawn up by T.Q. on 7 March 2014 and distributed to all participants.)

Subsequently, the National Institute of Standards and Technology (NIST), Gaithersburg, MD, USA, announced that it would organize a meeting to be held on 9 and 10 October 2014 to take these proposals forward.