

Activities of the Working Group on the Newtonian Constant of Gravitation

September 2016 – September 2017

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Introduction

The working group on the Newtonian Constant of Gravitation was created at the 28th General Assembly of IUPAP in November 2014. The purpose of the working group is to coordinate experimental efforts to measure the Newtonian constant or gravitation, G . This fundamental constant of nature describes the strength of gravity, the weakest of the four known fundamental interactions. The first laboratory measurement of the gravitational constant was carried out by Henry Cavendish at the end of the 18th century. In modern times, more than a dozen measurements have been described in the literature in the last 30 years. However, the agreement between the results is poor. The best results report relative standard uncertainties of about 20 parts in a million, but the relative difference between the largest and smallest value exceeds 500 parts per million. Clearly something is amiss. One task of the working group is to understand this problem.

Activities

The activities of the working group in the reporting period can be sorted in two broad categories: Support of experimental work and outreach.

Support of Experimental Work

While it is important to invent new methods to measure G , it is also important to recheck existing measurements. A basic tenet of the scientific method is that results are reproducible, i.e., conducting the same experiment a second time will yield the same result. The reproducibility of a single G experiment has never been checked, instead new ideas are pursued. The working group believes a good step to understand the discrepancy of different experiments is to check the reproducibility of a single result. With the help of the working group the torsion balance that was used by T.J. Quinn and collaborators at the Bureau International des Poids et Mesures (BIPM) to measure the gravitational constant was transferred to the National Institute of Standards and Technology. There, an independent group of scientist is making a second measurement with nearly the original equipment. Data collection has started in the summer of 2017 and a preliminary result is expected at the end of 2017. A definitive result should be available by 2018. The measured result and its assigned uncertainty will yield interesting information on the reproducibility of one experiment which, in turn, could help understand the reproducibility of the whole data set.

Members of the working group have secured another big G experiment. The apparatus used by Faller and Parks at the Joint Institute for Laboratory Astrophysics in Boulder Colorado. The experiment is no longer in use and endangered of being discarded. To avoid losing this experimental hardware, the apparatus was moved with support of the working group to NIST Gaithersburg. The apparatus is now in a secure place and eventually a second measurement could be carried out with this equipment.

Communication and Outreach

The working group is informing the task group of fundamental constants (TGFC) under the auspices of the Committee on Data for Science and Technology on possible new results.

Two members of the working group have written a review article on the measurement of G . The article is currently in the peer review process.

Future work

The working group is planning a face to face meeting at the General Relativity (GR 22) in Valencia in July 2019. The GR conferences are organized by the International Society of General Relativity, an affiliated commission of IUPAP. A session on recent measurements of the gravitational constant is also planned at the meeting.

Continuation of the working group

The working group asks the general assembly of IUPAP to recommend continuation of the working group until the next general assembly. An estimated life time of the working group is approximately 10 years.