Calculation of Newton’s gravitational constant

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Abstract

Newton’s gravitational constant at laboratory scale experiments is numerically calculated using number constants and the fundamental constants $\hbar$ (Planck’s quantum of action), $c$ (velocity of light in vacuum) and $m_e$ (electron mass).

Keywords: Fundamental constants, Newton’s constant, dimensionless gravitational constant, number constants.

Currently no established theoretical formula is known which manifests a quantitative relationship between Newton’s gravitational constant ($G_N$) and other natural constants. Since Newton’s theory does not make a statement about $G_N$ either, it only remains to determine $G_N$ experimentally. There are many publications on experiments, but many authors disagree about its true value. While the 2014 CODATA recommended value of $G_N$ was $6.674\,08(31)\times10^{-11} \, m^3 s^{-2} kg^{-1}$ with an uncertainty of $\approx 50$ ppm, it was changed to $6.674\,30(15)\times10^{-11} \, m^3 s^{-2} kg^{-1}$ in 2018 with half the uncertainty. Most physicists believe that the constant $G_N$ cannot be calculated and is in no way related to other constants. In the following, a simple numerical relationship using number constants [1] and natural constants is proposed.

The empirical constant $G_N$ shall be equal to the product $\lambda\, \alpha_{grav}\, m_{grav}^{-2} \{\hbar c/m_e^2\}_{\text{Codata}}$. The dimensionless quantity $\alpha_{grav}$ stands for the gravitational coupling parameter of two particles of mass $m_{grav}$ analogous to the electromagnetic coupling parameter $\alpha$ and is $(5/3)\,(2\pi^8/9)^{-9}$ [1] or $\approx 5.22\,10^{-39}$. The mass $m_{grav}$ in units of the electron mass $m_e$ is also without units and has the numerical value $2^{-3}\pi^{25/3}$ [1] or $\approx 1737$. The term $\{\hbar c/m_e^2\}_{\text{Codata}}$ defines the physical unit $m^3 s^{-2} kg^{-1}$ of $G_N$ with respect to the SI, and the heuristic coefficient $\lambda$, which should be a simple math expression and numerically of the order of $\approx 1$, results as a first approximation by comparing the product ansatz with experimental data. If $\lambda$ is set to $1+(1/9)^2$, a possible “theoretical” value of the Newton constant of $\approx 6.673\,97\,10^{-11} \, m^3 s^{-2} kg^{-1}$ can be extracted, which is within the error limits of the 2014 CODATA value, but outside the error limits of 2018. The origin of the term $1+(1/9)^2$ is unclear. Intriguingly, the total number of stable elements is $9^2$ if the element bismuth is included. More experiments are needed to clarify whether the ansatz creates a concise connection between $G_N$ and the rest of physics, or whether the good agreement is a numerical coincidence.

References