How the Universal Gravitational Constant Varies

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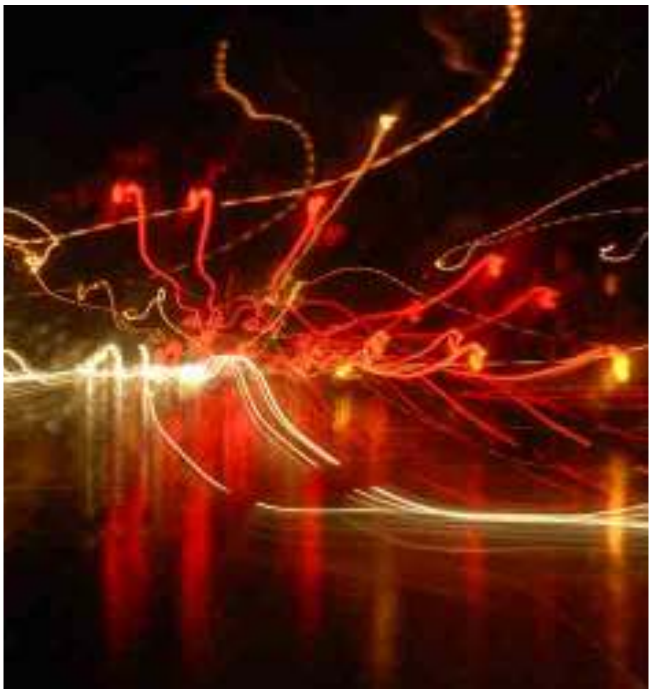

Physics is based on the assumption that certain fundamental features of nature are constant. Some constants are considered to be more fundamental than others, including the velocity of light c and the Universal Gravitational Constant, known to physicists as Big G. Unlike the constants of mathematics, such as p, the values of the constants of nature cannot be calculated from first principles: they depend on laboratory measurements. As the name implies, the physical constants are supposed to be changeless. They are believed to reflect an underlying constancy of nature, part of the standard assumption of physics that the laws and constants of nature are fixed forever.

Are the constants really constant? The measured values continually change, as I show in my book *Science Set Free* (*The Science Delusion* in the UK). They are regularly adjusted by international committees of experts know as metrologists. Old values are replaced by new "best values", based on the recent data from laboratories around the world.

Within their laboratories, metrologists strive for ever-greater precision. In so doing, they reject unexpected data on the grounds they must be errors. Then, after deviant measurements have been weeded out, they average the values obtained at different times, and subject the final value to a series of corrections. Finally, in arriving at the latest "best values", international committees of experts then select, adjust and average the data from an international selection of laboratories.

Despite these variations, most scientists take it for granted that the constants themselves are really constant; the variations in their values are simply the result of experimental errors.

The oldest of the constants, Newton's Universal Gravitational Constant, known to physicists as Big G, shows the largest variations. As methods of measurement became more precise, the disparity in measurements of G by different laboratories increased, rather than decreased.

Between 1973 and 2010, the lowest average value of G was 6.6659, and the highest 6.734, a 1.1 percent difference. These published values are given to at least 3 places of decimals, and sometimes to 5, with estimated errors of a few parts per million. Either this appearance of precision is illusory, or G really does change. The difference between recent high and low values is more than 40 times greater than the estimated errors (expressed as standard deviations).

What if G really does change? Maybe its measured value is affected by changes in the earth's astronomical environment, as the earth moves around the sun and as the solar system moves within the galaxy. Or maybe there are inherent fluctuations in G. Such changes would never be noticed as long as measurements are averaged over time and averaged across laboratories.

In 1998, the US National Institute of Standards and Technology published values of G taken on different days, revealing a remarkable range. On one day the value was 6.73, a few months later it was 6.64, 1.3% lower. (The references for all the data cited in this blog are given in *Science Set Free/The Science Delusion*.)

In 2002, a team lead by Mikhail Gershteyn, of the Massachusetts Institute of Technology, published the first systematic attempt to study changes in G at different times of day and night. G was measured around the clock for seven months, using two independent methods. They found a clear daily rhythm, with maximum values of G 23.93 hours apart, correlating with the length of the sidereal day, the period of the earth's rotation in relation to the stars.

Gershteyn's team looked only for daily fluctuations, but G may well vary over longer time periods as well; there is already some evidence of an annual variation.

By comparing measurements from different locations, it should be possible to find more evidence of underlying patterns. Such measurements already exist, buried in the files of metrological laboratories. The simplest and cheapest starting point for this enquiry would be to collect the measurements of G at different times from laboratories all over the world. Then these measurements could be compared to see if the fluctuations are correlated. If they are, we will discover something new.

If the raw data from laboratories around the world were published online, showing the measured values of G at different dates and times, anyone interested could look for patterns. Are the variations in different laboratories correlated, rather than being random errors? This could be an exemplary exercise in open, participatory science.

If you have access to raw data, or would like to help with this project, please get in touch with me at sheldrake@sheldrake.org