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Reply

Reply to the Comment by M. Pitkin

J. D. Anderson[1(a)], G. Schubert[2], V. Trimble[3] and M. R. Feldman[4]

[1] *Jet Propulsion Laboratory, California Institute of Technology - Pasadena, CA 91109, USA*
[2] *Department of Earth, Planetary and Space Sciences, University of California, Los Angeles Los Angeles, CA 90095, USA*
[3] *Department of Physics and Astronomy, University of California Irvine - Irvine, CA 92697, USA*
[4] *Private researcher - Los Angeles, CA 90046, USA*

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The comment by M. Pitkin [1] on our *EPL* article "Measurements of Newton's gravitational constant and the length of day" claims to provide evidence that a constant G measurement model with an additional Gaussian noise term is "hugely favoured" over models employing sinusoidal terms when using a Bayesian model selection procedure. Unfortunately, we were unable to replicate his claims with our own independent analysis testing the hypotheses of the following three scenarios for the G measurements:

1) Constant value: $G = a_0$.

2) Constant plus a sinusoidal term with period of approximately 6 years: $G = a_0 + a_1 \cos\left(\frac{2\pi t}{P_1}\right) + b_1 \sin\left(\frac{2\pi t}{P_1}\right)$.

3) Constant plus sinusoidal terms with two different periods of approximately 6 years and 1 year: $G = a_0 + a_1 \cos\left(\frac{2\pi t}{P_1}\right) + b_1 \sin\left(\frac{2\pi t}{P_1}\right) + a_2 \cos\left(\frac{2\pi t}{P_2}\right) + b_2 \sin\left(\frac{2\pi t}{P_2}\right)$.

We used a non-linear regression analysis with a minimization of the L1 norm to determine the best fit values for the input parameters of each of the above cases (*i.e.* for a_i, b_i and P_i values). After fitting to the G data, we found normalized σ values of 4.0, 2.6 and 2.0 for the weighted residuals of scenarios 1), 2) and 3), respectively, suggesting the two-period model is favored. We also computed histograms for the 19 weighted residuals

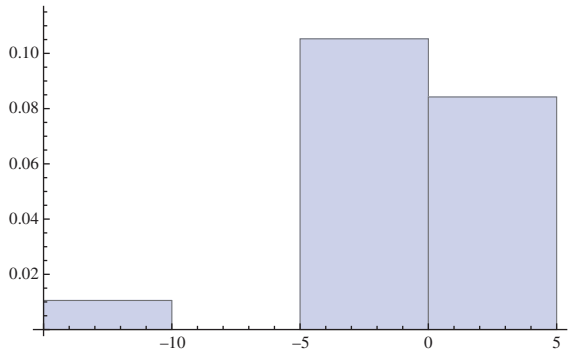

Fig. 1: (Colour on-line) Probability density function of the normalized residuals about a weighted mean G model (hypothesis 1)).

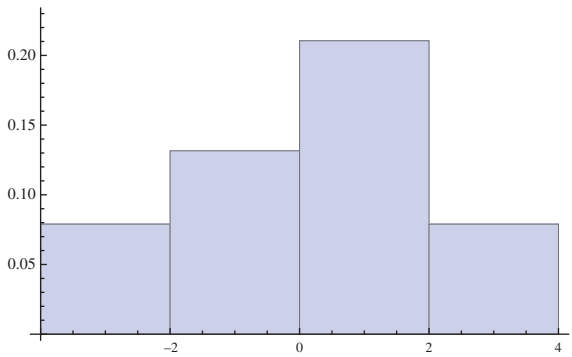

Fig. 2: (Colour on-line) Probability density function of the normalized residuals about a constant plus two-period sinusoid model (hypothesis 3)).

[(a)] Retired

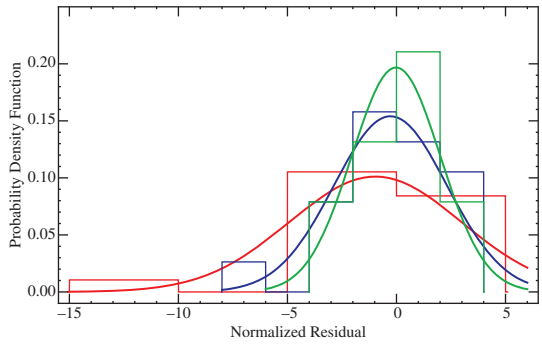

Fig. 3: (Colour on-line) Probability density functions of the normalized residuals for all three hypotheses (red: hypothesis 1), blue: hypothesis 2), green: hypothesis 3)). Overlayed are fitted normal distributions for each hypothesis with clear indication that hypothesis-3) residuals have a tighter Gaussian fit than the others.

and best-fit probability density functions for the three hypotheses. Importantly, the probability density function of the weighted residuals about a mean value of the G measurements (hypothesis 1)) follows more of a uniform distribution whereas for the two-period sinusoidal model (hypothesis 3)) the probability density function of the weighted residuals appears to follow a normal distribution, suggesting a possible error in Pitkin's analysis. See figs. 1–3 for our outputs from `Mathematica`. Thus, we stand by our conclusions of potential periodic terms in the reported G measurements (see our added appendix of [2] in response to [3] for our logic with a two-period sinusoidal model).

REFERENCES

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[3] Schlamminger S., Gundlach J. H. and Newman R. D., *Phys. Rev. D*, **91** (2015) 121101(R).