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The changing rotation period of 3200 Phaethon

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3200 Phaethon is one of the largest potentially hazardous asteroids. It is also the first asteroid to be discovered in spacecraft images, the parent body of the Geminid meteor stream, and the target of JAXA's upcoming DESTINY+ mission. We have developed a physical model of Phaethon's shape and rotation state, using radar data from Arecibo and Goldstone in 2007 and 2017, stellar occultations from 2019 through 2021, and lightcurves from many apparitions (from 1989 through 2021). Phaethon has a volume-equivalent diameter of about 5.3 kilometers. It is approximately spheroidal with an equatorial ridge, resembling the shapes of 101955 Bennu and 162173 Ryugu. The earliest available lightcurve of Phaethon is from 1989 October 9 (published in Wisniewski et al. 1997). Hanuš et al. (2016) noticed that their shape model's rotation phase differed from that 1989 observation by about 20 minutes. They noted that this may be from Phaethon's rotation period changing due to activity, but they could not say whether this was real or just a timing error in that one lightcurve, since the next lightcurves are from 1994. A model with a constant rotation period provided a good fit to all of the data from 1994 through 2020. However, this model could not adequately fit the lightcurves that were acquired from four different observatories in 2021. There was a difference of about 15 minutes between the predicted and observed rotation phases — clearly greater than what the observations' uncertainties could permit. We initially considered that Phaethon's rotation period may have changed before the 2021 observations, perhaps due to activity when it was near perihelion in December 2020. However, we found that a constant rotational acceleration provides a good fit to all of the data from 1989 through 2021, clearly accounting for the discrepancies seen in 1989 and 2021 while also slightly improving the model's agreement with the data during other apparitions. We find that Phaethon's sidereal rotation period in December 2017 was 3.603944 hours. Its spin rate is increasing at a rate of 2.1×10^{-6} deg/day^2, which corresponds to its rotation period decreasing by about 4 milliseconds per year.