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Is there PlanetX/Nemesis?

L. Iorio
F.R.A.S. Viale Unità di Italia 68, 70125, Bari (BA) Italy (lorenzo.iorio@libero.it)

Abstract

We use the precessions of the perihelia of some planets of our Sun to preliminarily constrain the minimum distance at which a putative distant object may exist in the remote peripheries of the solar system for different values of its mass.

1 Planetary perturbations of a putative X/Nemesis

We have shown that a putative distant body X, not yet discovered, would induce non-vanishing secular precessions of the longitudes of the perihelion and the node of a known planet P of the solar system. In particular, the resulting perihelion precession would be retrograde so that it would be able to explain the anomalous perihelion precession of Saturn recently determined from an analysis including radio-technical data from Cassini. An investigation of the tidal parameter of X as a function of its ecliptic longitude and latitude showed that its maximum value occurs for X located perpendicularly to the ecliptic, while its minimum occurs for X lying in the ecliptic. Accordingly, it has been possible to determine the present-day distance of X for different postulated values of its mass. Rock-ice planets as large as Mars and the Earth would be at about 80 au and 150 au, respectively, while a Jupiter-like gaseous giant would be at approximately 1 kau. A typical brown dwarf ($M = 80M_{\rm J}$) would be at about 5 kau, while Sun-sized body would be at approximately 10 kau. If it is difficult to believe that a main-sequence Sun-like star exists at just 10 kau from us, the distances obtained for terrestrial-type planets are substantially in agreement with theoretical predictions existing in literature about the existence of such bodies which would allow to explain certain features of the Edgeworth-Kuiper belt. Incidentally, let us note that our results rule out the possibility that the hypothesized Nemesis can be the Sun-like object X that may be responsible of the anomalous perihelion precessions of Saturn, also because, at approximately just 10 kau from us, its orbital period would amount to 1-10 Myr, contrary to the 26 Myr periodicity in extinction rates on the Earth over the last 250 Myr which motivated the Nemesis proposal. Moreover, our Sun-sized body X would not penetrate the Oort cloud which is believed to extend from 50 kau to 150 kau. The tidal parameter of Nemesis would be, instead, $2 - 4$ orders of magnitude smaller than the present-day level of accuracy in measuring it (10^{-26} s^{-2}). On the other hand, if our X had a distance of about 88 kau, as predicted for Nemesis, our result for its tidal parameter would imply a mass of $300M_{\odot}$.

For a particular position of X, i.e. along the direction of the Galactic Center, our results hold also for the recently proposed form of the External Field Effect in the framework of MOND in the sense that it would be able to explain the perihelion precession of Saturn in such a way that it mimics the existence of a body in the direction of the center of the Milky Way. The associated parameter q ranges from 0.2 to $0.4 - 1$, while the theoretical predictions for various choices of the interpolating function and various values of the Galactic field at the Sun's location are $10^{-2} \leq -q \leq 0.3$.

Anyway, further data analyses of enlarged radio-ranging datasets from Cassini by different teams of astronomers are required to confirm the existence of the anomalous perihelion precession of Saturn as a real physical effect needing explanation.

Finally, let us note that a complementary approach to the problem consists of re-analyzing all the planetary data with modified dynamical models explicitly including also a planet X and solving for a dedicated parameter accounting for it.