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Results on stellar occultations by (307261) 2002 MS4

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Abstract

Transneptunian Objects (TNOs) are the remnants of our planetary system and can retain information about the early stages of the Solar System formation. Stellar occultation is a ground-based method used to study these distant bodies which have been presenting exciting results mainly about their physical properties. The big TNO called 2002 MS4 was discovered by Trujillo, C. A., & Brown, M. E., in 2002 using observations made at the Palomar Observatory (EUA). It is classified as a hot classical TNO, with orbital parameters a = 42 AU, e = 0.139, and i = 17.7º. Using thermal measurements with PACS (Herschel) and MIPS (Spitzer Space Telescope) instruments, Vilenius et al. 2012 obtained a radius of 467 +/- 23.5 km and an albedo of 0.051.

Predictions of stellar occultations by this body in 2019 were obtained using the Gaia DR2 catalogue and NIMA ephemeris (Desmars et al. 2015) and made available in the Lucky Star web page (https://lesia.obspm.fr/lucky-star/). Four events were observed in South America and Canada. The first stellar occultation was detected on 09 July 2019, resulting in two positives and four negatives

chords, including a close one which proven to be helpful to constrain the body's size. This detection also allowed us to obtain a precise astrometric position that was used to update its ephemeris and improve the predictions of the following events. Two of them were detected on 26 July 2019, separated by eight hours. The first event was observed from South America and resulted in three positive detections, while the second, observed from Canada, resulted in a single chord. Another double chord event was observed on 19 August 2019 also from Canada.

Due to its size, it is expected that 2002 MS4 is in hydrostatic equilibrium. Thirouin, A. 2013 obtained a rotational light curve of 2002 MS4 and determined two possible periods (7.33 h and 10.44 h) with low amplitude variation (0.05 +/- 0.01 mag). Admitting that it has a Maclaurin shape, the projected limb in the sky plane for Earth-based observers should be the same in the 09 July and 26 July events. The multi-chord detection allows determining an interval of parameters for size and shape. Considering that the same figure should have been observed in the 09 July event, we could use the both chords and the negative observations to constrain its physical parameters. With that, we could determine that 2002 MS4 has an equivalent radius of 385 +/- 1 km (Figure 1). Our results indicate that this TNO is about 100 km smaller in diameter than the value obtained by Vilenius et al. 2012, implying an albedo of 0.076 (Hv = 4.0 +/- 0.6) . The astrometric positions derived from these data were also helpful to improve forthcoming stellar occultations, in special the one crossing Europe on 08 August this year. More data from stellar occultations and observations of rotational light curves will help to confirm these results and assumptions.

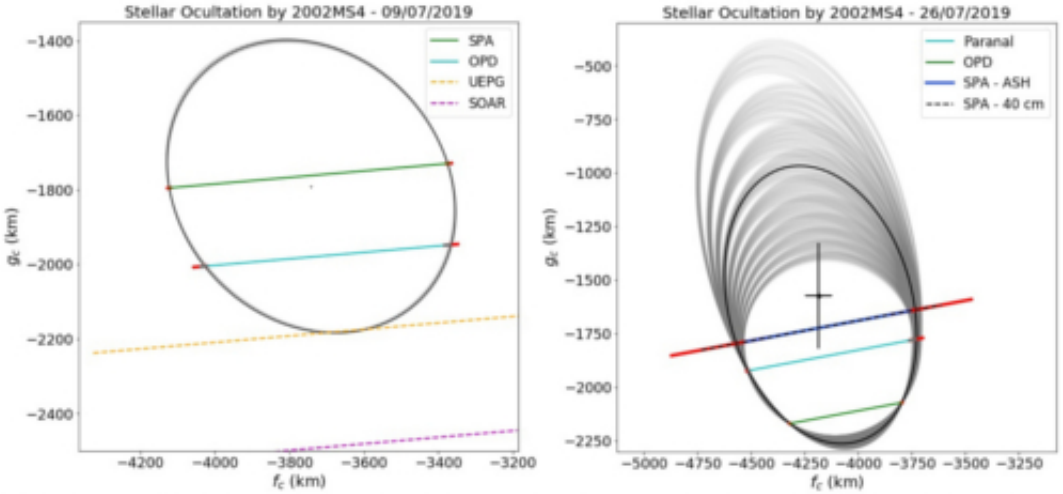

Figure 1: The positive chords are presented in blue, cyan and green, segments with error bars in red. The black ellipse represents the best solution whereas the grey ones are the possible solutions in the 1σ error zone. The black cross represents the 1σ uncertainty of the object's centre. On the left side the solutions for the 09 July event, constrained by the limits imposed by the 26 July event, shown on the right side. Note the negative chord from Ponta Grossa/BRA presented by the orange line, allowed constraining the ellipse solutions.

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