RETURN OF AN EARTH-GRAZING ASTEROID; M. Connors, University of Alberta

The Earth-grazing fireball of August 10, 1972 was sufficiently well observed to have an orbit determined. That orbit has been integrated forward, including planetary perturbations, to predict that the object will return to the vicinity of Earth in late July 1997. The object may be recoverable by directed telescopic searches at this approach.

A bright meteoric fireball observed widely in western North America on the afternoon of August 10 1972 remains the unique known natural object to have entered Earth's atmosphere and skipped off to return to interplanetary space. This encounter was also the closest passage of an asteroidal object by our planet, being at one Earth radius or approximately .000045 AU as opposed to .001 AU for the closest asteroid observed telescopically [1]. Analysis using meteor observing techniques permitted determination of the object's orbital parameters (with standard errors) before and after the encounter [2]. The semimajor axis (1.661 AU before; 1.4715(0.0009) AU after) and eccentricity (0.3904 before; 0.3633(0.0004) after) are typical of known near-Earth asteroids. Using the 1972 orbit, Ceplecha [3], while stressing the need to consider changes to this orbit from planetary perturbations, predicted another close approach to Earth between July 30 and August 16 1997. Precision calculations, using the RADAU integrator [4] and incorporating the effects of all planets except Pluto, support this prediction. Planetary positions retained an accuracy of $10^{-5}$ AU per ten years of simulation, so that limits on precision arise from the standard errors of the initial orbit. The most probable date of closest approach is found to be July 31 1997 with the approach distance being .08 AU. While this is not particularly close (being about 30 times the distance of the Moon), it is nearer than about 80% of encounters recently listed as radar observing opportunities [5]. The expected small size of the object (possibly only several meters diameter) would make it faint and random rediscovery unlikely. The object may be similar to asteroid 1991BA [6] and then would have a stellar magnitude at .08 AU of only about 24, a factor of 100 fainter than new asteroids being detected by present searches. The most favorable approach within the standard error given above (only the variation in semimajor axis of the orbit being of much consequence due to the associated change in period) is August 17 1997 at .05 AU. The object would be in twilight skies at nearest approach but would have a solar elongation of 138 degrees ten days later while still at .08 AU, possibly allowing dark sky detection. A search in the regions of sky indicated by an ephemeris based on the 1972 data would enhance chances of detection. The main return from such a detection would be determination of a good orbit for one of the very small objects which are the most numerous but hardest to dectect among the near-Earth asteroids [7]. Further, the basic 1972 orbit is in 14:25 resonance with Earth. Near encounters with this object will continue to occur every 25 years but the resonance makes accurate prediction difficult without a precision orbit. In the case of an impact, the most likely mass and relative velocity of the object correspond to only $10^{13}$ to $10^{14}$ joules or roughly one kiloton of energy, near the low end of what could cause terrestrial effects. Nevertheless the evaluation of future impact probability (or study/deflection opportunity), based on a good orbit, would be of great interest. The 1997 encounter should pose little danger but may allow study of this interesting object.

EARTH-GRAZING ASTEROID: M. Connors

References

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