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The effects of disc warping on the inclination of planetary orbits

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Abstract

Recent observations indicate that a significant number of short period extrasolar planets are on an orbit which is inclined with respect to the equatorial plane of the star, and therefore with respect to the plane of the protostellar disc that existed around the star when it formed. Before these observations were made, the common belief was that planets had formed in the disk and therefore their orbits lied in its plane. As of today, there is no general explanation for why some orbits are inclined. In this paper, we investigate the effect of a warped disc on the inclination of the orbit of a planet that lies in the inner parts of the disc, which are supposed to be flat. We show that, in general, the secular gravitational interaction between the planet and the outer parts of the disc makes the planetary orbit precess. Therefore, the orbital plane becomes inclined relative to the disc's inner parts, by an angle that may be significant. This process does not change the planet's eccentricity. When the warp is severe though, the planetary orbit no longer precesses but both its inclination and its eccentricity are pumped up to very high values. The orbit may even become retrograde.