Rotation-induced YORP break-up of small bodies to produce post-main-sequence debris

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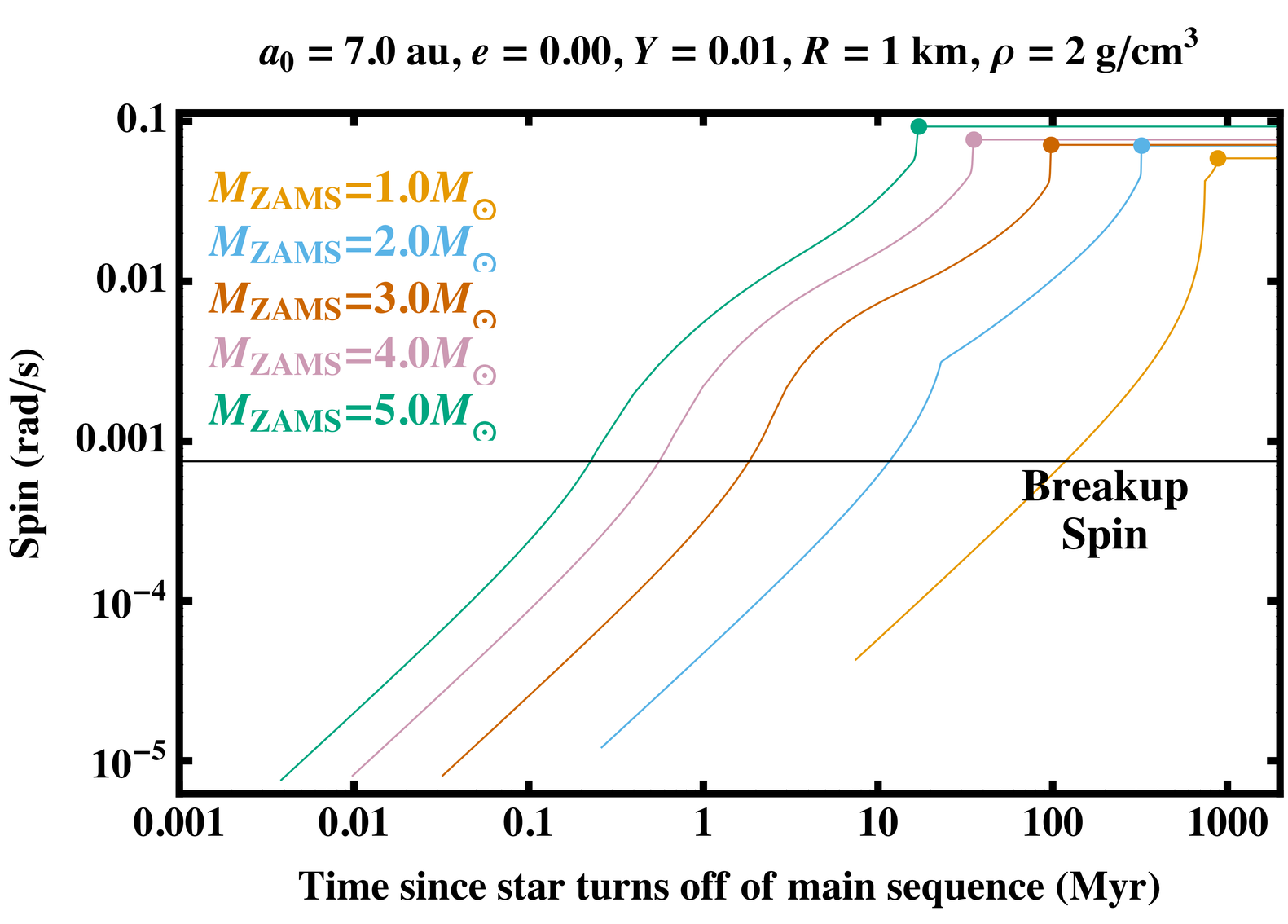
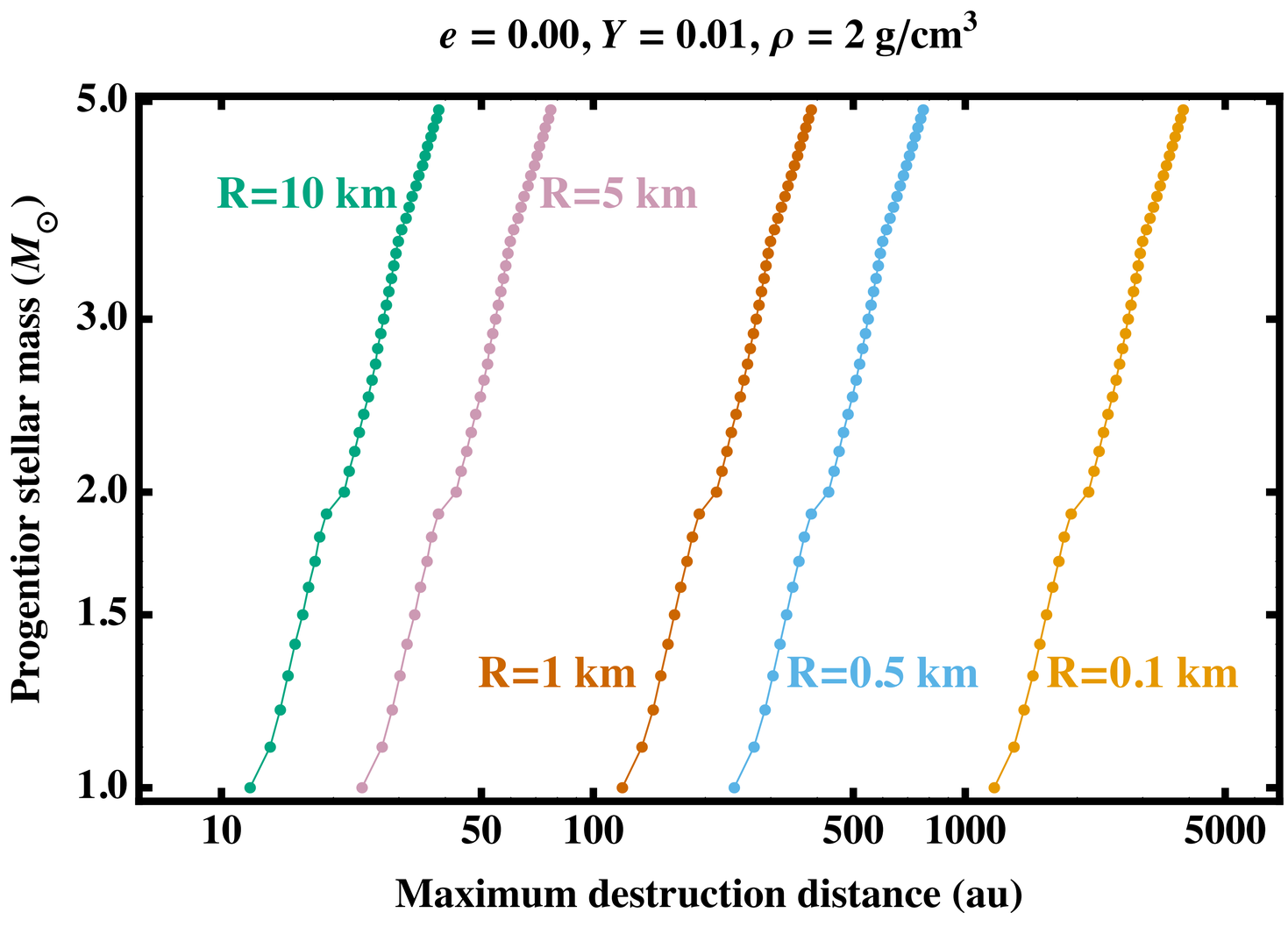
Veras et al. (MNRAS, 2014, 445, 2794)

We hypothesize that the in situ break-up of small bodies such as asteroids spun to fission during the giant branch phases of stellar evolution provides an important contribution to the debris orbiting and ultimately polluting white dwarfs.



A demonstration of why asteroid belts will be destroyed during giant branch evolution. This plot features the spin-up of objects with 1 km radii, an initial semimajor axis of 7.0 au and an eccentricity of zero. The objects have typical asteroid densities of ρ = 2 g cm^{-3} and a 1% degree of asymmetry. The horizontal black line represents the critical spin value at which an asteroid will tear itself apart. All objects are assumed to begin life on the giant branch with no spin, and the curves are drawn from the beginning of the red giant branch phases. Dots indicate when the stars become white dwarfs. The stars are all assumed to initially harbour Solar metallicity.



The maximum (final) distance, or semimajor axis, at which asteroids with forever circular orbits, a radius R, density of 2 g cm^{-3} and asymmetry parameter 0.01 can be destroyed by YORP. Each dot represents the result of an integration initialized with the highest initial semi-major axis for which destruction occurs.

We find that giant star radiation will destroy nearly all bodies with radii in the range 100 m–10 km that survive their parent star's main-sequence lifetime within a distance of about 7 au. The resulting debris field, which could extend to thousands of au, may be perturbed by remnant planetary systems to reproduce the observed dusty and gaseous discs which accompany polluted white dwarfs.