Contribution ID: **27** Type: **not specified**

Orbital stability of circumbinary exoplanets orbiting double white dwarfs.

Friday 17 January 2025 09:50 (20 minutes)

The formation and stability of planetary systems around compact binaries, such as double white dwarfs (DWDs), represent a frontier in planetary science, with implications for understanding planet formation in extreme environments. Recent theoretical studies suggest that second-generation planets can form in circumbinary discs around DWDs, potentially evolving into systems hosting sub-Neptunian to giant planets. However, the long-term orbital stability of these systems remains poorly explored. In this study, we present results from N-body simulations investigating the dynamical stability of circumbinary planetary systems around DWDs over timescales of a few million years. Employing a hybrid symplectic integrator tailored for circumbinary systems, we simulate two-, three-, and four-planet configurations, analyzing their evolution through metrics such as orbital spacing, center-of-mass variation, and Normalized Angular Momentum Deficit (NAMD). Our findings demonstrate that planetary systems around DWDs can remain stable over the studied timescales. Two-planet systems exhibit no catastrophic events, while higher multiplicity systems often experience phases of dynamical instability, leading to planet loss. Ultimately, most systems stabilize with two surviving planets, increasing their prevalence by 23% relative to their initial abundance. Conversely, systems with higher initial multiplicities face significant reductions, with four-planet configurations decreasing by 42%. Notably, 4% of multi-planet systems are disrupted entirely due to planetary collisions with the central binary. Our work advances the understanding of planetary system dynamics in post-main-sequence environments and offers insights into the formation and survival of planets in circumbinary systems.

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Session Classification: Post MS systems