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## Life in the Dark: Tidal Heating and Urability on Moons of Rogue Planets

*Monday, December 15, 2025 4:40 PM (20 minutes)*

Rogue planets may retain moons after ejection from their host systems. The eccentric orbits of such moons can enable tidal heating sufficient for subsurface oceans to persist even without stellar irradiation. We test this through several thousand N-body simulations of planet–moon systems expelled by type II supernovae. All moons of rogue planets remain bound, with semi-major axes changing by  $<0.2\%$  and eccentricities excited modestly ( $\lesssim 10^{-3}$  in single moon systems,  $\simeq 2 \times 10^{-2}$  in resonant pairs). In 12–15% of cases, tidal heating reaches 0.1–10 times that estimated on Europa or Enceladus, suggesting a possibility to sustain subsurface oceans over gigayears. Such moons thus emerge as stable, tidally active, and potentially urable environments that allow for the emergence of life even in the absence of starlight.

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