Contribution ID: **11** Type: **not specified**

Soft No More: Gas Shielding Protects Soft Binaries from Disruption in Gas-rich Environments

Tuesday 26 August 2025 12:00 (20 minutes)

Binaries in dense environments are traditionally classified as soft or hard based on their binding energy relative to the kinetic energy of surrounding stars. Heggie's law suggests that stellar encounters tend to soften soft binaries and harden hard binaries, altering their separations. However, interactions with gas in such environments can significantly modify this behavior. This study investigates the impact of gas on binary softening and its consequences. We find that gas interactions can actually harden binaries, extending the soft–hard boundary to larger separations. This introduces a "shielding radius" within which binaries are likely to harden due to gas interactions, surpassing the traditional soft–hard limit. Consequently, a notable portion of binaries initially classified as "soft" may become "hard" when both gas and stars are considered. We propose a two-stage formation process for hard binaries: initial soft binary formation, either dynamically or through gas-assisted capture, followed by gas-induced hardening before eventual disruption. In environments with low gas density but high gas content, the shielding radius could exceed the typical hard–soft limit by 1 order of magnitude, leading to a significant fraction of originally soft binaries effectively becoming hard. Conversely, in high-gas-density environments, gas-induced hardening may dominate, potentially rendering the entire binary population hard. Gas hardening emerges as a crucial factor in shaping binary populations in gas-rich settings, such as clusters, star-forming regions, and possibly active galactic nucleus disks. This highlights the complex interplay between gas dynamics and stellar interactions in binary evolution within dense environments.

Presenter: Dr ROZNER, Mor (Cambridge & IAS)

Session Classification: Formation pathways