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Fe XVII Line Emission Problem

Iron, the most abundant heavy element in the universe, is essential for spectroscopic studies. X-ray astronomers use the emission lines from highly ionized iron states like Fe XVII to study properties of hot celestial plasmas. These emission lines, which result from atomic processes like electron-impact excitation, dielectronic recombination, resonance excitation, and charge exchange, allow researchers to diagnose electron temperature and density, elemental abundance, velocity turbulence, and opacity parameters of hot plasmas. However, for over four decades, the intensity ratio between two strong lines from 3d-2p transitions, 3C and 3D, has been low in lab experiments, differing from theoretical predictions of a high ratio. Similar discrepancies have also been observed in the ratio between line emission complexes 3d-2p and 3s-2p transitions. This has impacted the reliability of Fe XVII as a diagnostic tool in the astronomy and fusion communities. Here I will present targeted laboratory measurements [1-6] using electron beam ion traps and various spectrometers to measure individual line formation atomic processes that contribute to the overall line emission of Fe XVII. These measurements benchmark state-of-the-art atomic theories and improve atomic data in spectral plasma models, such as SPEX and AtomDB, which are crucial for achieving the scientific objectives of XRISM and Athena space missions.

References: [1] Shah et al., ApJ 2019; [2] Kühn, Shah et al., PRL 2020; [3] Grilo, Shah et al., ApJ 2021; [4] Grell, Leutenegger, Shah, ApJ 2021; [5] Gu, Shah et al., A&A 2019, 2020, 2022; [6] Kühn, ⋯, Shah, PRL 2022.

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