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X-raying highly charged ions with synchrotrons and free-electron lasers

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Strong ionizing radiation fields are ubiquitous in astrophysical environments. There, atomic matter appears mainly as highly charged ions (HCIs), which dominate radiation transport and plasma dynamics. Their spectroscopic signatures provide information on the composition, temperature, density, turbulence, and velocity of plasmas, e. g. those surrounding stars, X-ray binaries, active galactic nuclei, as well as those filling galaxy clusters and the intergalactic medium. The abundance and electronic properties of iron HCl make their X-ray transitions key to our understanding of these plasmas. The Ne-like Fe XVII is very interesting because it survives up to very high temperatures. The oscillator strengths of its transitions have puzzled observers, theorists, and laboratory astrophysicists for nearly fifty years. A series of experiments with electron beam ion traps at X-ray sources have finally confirmed advanced atomic structure calculations by steady improvements in resolution and signal-to-noise ratio. Their agreement in the range of a few percent is important for plasma diagnostics and astrophysics. The hopefully successful launch this August of XRISM, an X-ray space telescope equipped with a high-resolution X-ray microcalorimeter, will provide a wealth of X-ray data of unprecedented quality. The benchmarked advanced theory methods used to interpret our laboratory data will be very useful for analyzing the upcoming data streams and will enhance the scientific return from this mission and the upcoming Athena X-ray observatory.

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