SEMINAIRE ISMO

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How to form correlated plasmas from an ultra cold gas

Photoionizing cold or ultra cold gas samples forms ultra cold plasma. Such systems offer a novel regime for studying the collision physics of Coulomb systems in or near states of charged particle correlation such as dense astrophysical plasmas or laser induced plasmas in a laboratory setting. The state of charged particle correlation is quantified by the ratio between the Coulomb interaction energy and the kinetic energy of the ionized gas. In plasmas made out of laser-cooled gases, charged particle correlation introduces many body effects that alter the driving of collective mechanical modes.

Many experimental studies of ultra cold plasmas have provided a revealing glimpse of ionized gas dynamics under conditions that approach those necessary for ion and electron correlation. Reaching deep into the strongly-coupled regime, however, remains difficult due to charged particle dynamics such as disorder-induced- heating (DIH), which converts the Coulomb interaction energy due to the initially random distribution of the atoms into kinetic energy of the ions. Collisional relaxation, involving electrons, plays a particularly important role in the dynamics of such systems. Indeed electrons recombine with ions and undergo energy transfer collisions with Rydberg neutrals, in kinetic sequences that redistribute population and regulate electron temperature.

In our experiment, a single state Rydberg gas of nitric oxide entrained in a molecular beam evolves to form ultra cold plasma following an initial step of Penning ionization. Penning ionization consist of the ionization of one Rydberg neutral within a pair of nearest neighbors due to a strong dipole-dipole interaction. Penning ionization shapes a distinct initial ion distribution from the original random positions of the Rydberg molecules. I will discuss how this shaping reduces disorder induced heating and helps to keep the plasma correlated.

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