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Trapped Ion Thermometry and Mass Determination through Imaging VAISHNAVI RAJAGOPAL, BRIAN C. ODOM, Northwestern University — Laser cooled atomic ions and sympathetically cooled molecular ions form ordered structures in an ion trap. In the weak binding limit, where the linewidth of the cooling transition is much larger than the trap frequency, we measure the temperature of a string of laser cooled ions using the dependence of the spatial width of the ions on the normal modes of vibration of the string. This thermometry method is passive and avoids any resonant excitation and consequent heating of the ions. In the case of a mixed string, we use an active imaging method to determine the molecular composition of the co-trapped sympathetically cooled species. Here the collective motion of the ions is resonantly excited via an rf voltage applied to the endcaps. Our apparatus for making molecular ions without significant increase in background pressure could be of interest for future experiments, since it can potentially be applied to investigate chemical reactions with small cross-sections. Our molecule production and mass determination techniques are also promising for recyclable spectroscopy, where the pure string of atomic ions is restored after spectroscopy on a particular quantum state of the molecular ions.

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