

Plenary Talk PV VII We 9:15 E 415 und E 214
Tunable Quantum Gases in Optical Lattice Potentials —
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I will review our recent experiments with atomic and molecular quantum gases in optical lattices. I will first show how one can produce quantum gases of rovibronic ground state molecules with full control over all internal and external quantum degrees of freedom [1]. For the case of atomic quantum gases, for which one can tune the interaction parameter, I will discuss the preparation of an exotic many-body,

highly-correlated quantum phase in 1D geometry known as the super-Tonks-Girardeau (sTG) gas [2]. In contrast to the well-known case of the Tonks-Girardeau (TG) gas, interactions are strongly attractive for the sTG gas. Finally, I will report on the observation of the superfluid-to-Mott-insulator (SF-MI) phase transition for a strongly-interacting 1D gas. For sufficiently strong interactions, the insulating state is induced by an arbitrarily weak lattice, in striking contrast to the SF-MI transition observed for weakly-interacting 3D gases. [1] Quantum gas of rovibronic ground-state molecules in an optical lattice, J.G. Danzl et al., arXiv:0909.4700 (2009). [2] Realization of an excited, strongly correlated quantum gas phase, E. Haller et al., Science 325, 1224 (2009).