Cold Atom Experiments for Cold High-energy Physics

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There are common key words crossing atomic physics and hadron physics, for example, Feshbach resonance, Fermi superfluidity, BCS-BEC crossover, hydrodynamics, and so on, because their particle systems belong to a similar quantum system under low temperature and dilute conditions with a large scattering length, even if their energy scales are completely different. Therefore, it is possible to simulate fundamental physics in hadron physics with ultracold atoms as quantum simulator. Previously, we showed the equation of state of dilute neutron matter determined by an ultracold 6Li atom experiment [1,2]. Now, we have studied hydrodynamic expansion and cluster formation shown in a heavy ion collision. So far, share viscosity has been measured in the unitary regime. However, bulk viscosity has not been measured yet. I will present our recent experimental result to determine the equation of state for bulk viscosity in the unitary regime. For studying dynamics of cluster formation, it is necessary to detect only clusters with a spatial and time resolution in the many-body system. By exploring the bound-bound transitions from the Feshbach molecule to the electrically excited molecular states, we have found several optical transition lines to image only the Feshbach molecules. Using these transition lines, we can study various dynamics, such as the dissociation and recombination of Feshbach molecules due to collisions, and the formation of bound states when up-spins and down-spins collide.

References:

[1] M.H, Phys. Rev. X 7, 041004 (2017).

[2] M.H, IJMPE 28, 1930001 (2019).