Fano-Feshbach resonances observation in ultracold thulium gas

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Ultracold atomic gases are a powerful tool for quantum simulations. One of the most desirable feature of such systems is a tunable interaction between particles. Such control can be provided with scattering length variation via magnetically tuned Fano-Feshbach resonances [**?**]. Dipolar atoms such thulium are good candidates for quantum simulations since they have low field Fano-Feshbach resonances and a wide range anisotropic interaction [**?**].

We report about the s- and d-wave thulium Fano-Feshbach resonances observation in the magnetic field range between 0 and 24 Gauss at temperatures of atomic cloud between 2 and 12 μK. Atom ensembles were cooled and polarized to the lowest magnetic sublevel with a narrow line far detuned magneto-optical trap. Further cooling and experiments occur in the optical dipole trap operating on 532 nm. The measurement of Fano-Feshbach resonances was conducted by detecting losses of atoms from the optical dipole trap, caused by a significant increase of 3-body recombination in Fano-Feshbach resonances. The resonances measured were used to determine the sign on the background scattering length of the thulium. This was done by detecting temperature anomaly near one of the strong resonances, which was associated with the zero of the scattering length [**?**].

While all observed above resonances are formed by atoms been it the same ground state, from point of view of simulation it is interesting to have control over collisions of atoms in different ground states. This could be done via Fano-Feshbach resonances in atoms, which populates other magnetic sublevels. Thulium atom seems to be good candidate for this purpose as its magnetic moment is small enough to prevent strong dipolar relaxation. Such atomic states could be prepared with transitions between ground state hyperfine sublevels. In order to develop such technique, we have carried out microwave spectroscopy of cold thulium atom ground state.

References

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