Spectroscopy of Ultracold Plasma and Rydberg Gas Using the Autoionization Effect of Rydberg States

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A sensitive spectroscopic technique for studies of low-density ultracold plasmas and Rydberg gases based on the observation of autoionization resonances of Rydberg atoms is developed. The technique allows the detection of the plasma at ion and electron densities below 10^9 m^{-3} [1]. The experiments are performed with ultracold 40 Ca Rydberg atoms prepared in a continuously operating magneto-optical trap. The investigation of resonances at the two-photon and at the three-photon Rydberg transitions have been carried out using 672 and 798 nm CW resonant lasers and 2 GHz microwave radiation. The autoionization resonances are observed in fluorescence of single-charged 40 Ca ions at a wavelength of 397 nm. The dependence of the amplitude of the selected autoionization resonance on the density of the ions is obtained. The developed approach is effective and can be applied to study Rydberg states in different atoms.

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References

[1] B B Zelener, E V Vilshanskaya, S A Saakyan, V A Sautenkov, B V Zelener and V E Fortov, JETP Lett. **113**, 82 (2021)