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Superradiance and superradiance cascade in a cold Rydberg gas[1]

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— We report the observation of superradiance in a cold ^{85}Rb Rydberg gas. Specifically, the superradiant decay from the ns state to the (n-1)p state and from the nd to the (n-2)f state are studied. The observed signal is characterized by the amount of superradiance decay as a function of the total number of atoms, the delay and the electric field dependence. Compare with the superradiance in a room temperature Rydberg gas, two new features are observed in a cold Rydberg gas. First, the superradiance signal decays very fast, the lifetime of the 21f state decayed from the 23d state is 4us at density: $1.5X10^9cm^{-3}$. Second, the $5p_{3/2}$ state to the nf state transition happens at high density with the assistance of one superradiance photon. These new features lead to more interesting phenomena in a cold Rydberg gas, such as plasma. Moreover, the van der Waals interaction effect and the stark effect induced by free ions will be discussed. Furthermore, superradiance cascade will be presented. Another aspect of this study is that a threshold behavior in a cold plasma formation process suggests the existence of a coherent process. However, little research focuses on this phenomenon. The purpose of this paper is to show that superradiant decay is responsible for this threshold behavior and suprerradiant cascade decay and subsequent multibody collisions lead to the fast plasma formation process.

[1]The air force of scientific research

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