Decay modes of the Hoyle state in ^{12}C

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Recent experimental results give an upper limit to the direct decay of the Hoyle state into 3α of equal energy respect to the sequential decay into ^{8}Be+α less than 0.043% (95% C.L.). We performed one and two-dimensional tunneling calculations to estimate such a ratio and found it to be more than one order of magnitude smaller than experiment depending on the strength of the nuclear force [1]. This is within high statistics experimental capabilities. Our results can also be tested by measuring the high excitation energy states of ^{12}C decay modes where the ratio of direct to sequential decay might reach 10% at $E^*(^{12}C)$=10.3MeV. The link between a Bose Einstein Condensate (BEC) and the direct decay of the Hoyle state is also addressed. We discuss a hypothetical 'Efimov state' at $E^*(^{12}C)$=7.458MeV, which would mainly *sequentially* decay with 3α of equal energies: a counterintuitive result of tunneling. Such a state, if it would exist, is at least 3 orders of magnitude less probable than the Hoyle's, thus below the sensitivity of recent and past experiments.

[1] H. Zheng *et a*l., Phys. Lett. B **779**, 460 (2018).