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59

Observation of relaxation stages in the decay of a turbulent trapped superfluid

MADEIRA, Lucas[1]; ZHU, Ying[2]; BAGNATO, Vanderlei Salvador[1]; YUKALOV, Vyacheslav I.[3]; FRITSCH, Amilson Rogelso[1]; SAB, Sarah[1]; ARMIJOS, Michelle Alejandra Moreno[1]; NAZARENKO, Sergey[2]; OROZCO, Arnol Daniel García[1]; TELLES, Gustavo[1]

michelle.moreno@ifsc.usp.br

[1]Instituto de Física de São Carlos – USP; [2]Université Côte d'Azur, CNRS, Institut de Physique de Nice; [3]Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research

Many-body phenomena encompass a wide range of systems, from fundamental particles to the dynamics of galaxies at cosmological lengths. These phenomena are predicted to feature universal dynamic scaling, meaning that common underlying principles govern their behavior. Our work explores the decaying turbulence in trapped Bose-Einstein condensates, showing evidence that the universal processes related to the emergence of direct and inverse particle cascades constitute stages of its relaxation. Our findings show a direct particle cascade from low to high momenta, a consequence of the energy injection in the system, exhibiting a characteristic universal scaling. (1) This stage is followed by an inverse particle cascade responsible for repopulating the previously depleted condensate. Both cascades are explained through self-similar solutions provided by wave turbulence theory. (2) These findings provide important insights into the relaxation stages of out-of-equilibrium quantum many-body systems.

Palavras-chave: Bose-Einstein condensate; Wave turbulence; Non-equilibrium systems.

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