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Extracting Equation of State of a Trapped Gas from the Frequency of its Collective Excitations[1] MAXIM OLSHANII, University of Massachusetts Boston, HÉLÈNE PERRIN, Institut Galilée, Université Paris 13 and CNRS — We address the question of a relationship between frequency of small collective excitations of an unknown trapped cold gas and its Equation of State (EoS). In particular, we compare the frequency-EoS relationship obtained using a nonlinear double amplitude-coordinate perturbative expansion [M. Olshanii, H. Perrin, V. Lorent, PRL 105, 095302 (2010)] with the formula resulting from a scaling variational anzats [G.E. Astrakharchik, R. Combescot, X. Leyronas, S. Stringari, PRL 95, 030404 (2005)] and show that for power-law EoS's, the two agree exactly. We further compare predictions of both methods with *ab initio* numerical results. We argue that the frequencies of collective excitations represent a new reliable second thermodynamical axis, to complement the existing one, based on density profiles [N. Navon, S. Nascimbène, F. Chevy, C. Salomon, Science 328, 729 (2010)] .

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Maxim Olshanii
University of Massachusetts Boston

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