

viscosity of a UFG is negligible, its shear viscosity is [negligible](#) suggesting that dissipation could be a viable regularization mechanism for the singular hydrodynamics.

In contrast, a dispersive regularization of the hydrodynamic equations, proposed in [23](#), uses an extended Thomas-Fermi functional approach. The first-order correction to the hydrodynamic system is the addition of a von Weizsacker type [\[24\]](#), dispersive correction term to the right-hand side of [\(2\)](#) of the form $\frac{\hbar^2}{4m} \cdot (\log)$, where \hbar is a dimensionless parameter with accepted value 0.25 [\[13\]](#). Note that studies in the weakly interacting regime have led to alternative dispersive models [\[5\]](#)

couples to the shock speed by invoking the jump conditions to (A23) gives the approximate initial data, give the ordinary differential equation

$$s(t) = \frac{u}{S} \Big|_{z=s(t)} \quad (A23) \quad s(1/5 + \epsilon) = \frac{5^{17/7}}{35^{5/7} S}, \quad 0 < \epsilon < 1, \quad (A24)$$

The initial condition must be prescribed just after the interaction time so that a shock is created, say $t_0 + \epsilon$, where $0 < \epsilon < 1$. Then, inserting the Taylor series expansion, $s(1/5) = 0$, $s(1/5 + \epsilon) = \dot{s}(1/5) \epsilon + \dots$, into (A22) and (A23), which we use as the initial condition to numerically solve the system (A22) and (A23). For the simulations presented, we took $\epsilon = 5 \times 10^{-5}$ and found it to be sufficiently small to accurately resolve the shock dynamics.

[1] M. Kulkarni and A. G. Abanov, *Phys. Rev. A* **86**, 033614 (2012).
 [2] M. R. Matthews, B. P. Anderson, P. C. Haljan, D. S. Hall, C. E. Wieman, and E. A. Cornell, *Phys. Rev. Lett* **83**, 2498 (1999).
 [3] K. W. Madison, F. Chevy, W. Wohlleben, and J. Dalibard, *Phys. Rev. Lett* **84**, 806 (2000).
 [4] M. W. Zwierlein, J. R. Abo-Shaeer, A. Schirotzek, C. H. Schunck, and W. Ketterle, *Nature (London)* **435**, 1047 (2005).
 [5] S. Burger, K. Bongs, S. Dettmer, W. Ertmer, K. Sengstock, A. Sanpera, G. V. Shlyapnikov, and M. Lewenstein, *Phys. Rev. Lett* **83**, 5198 (1999).
 [6] K. E. Strecker, G. B. Partridge, A. G. Truscott, and R. G. Hulet, *Nature (London)* **417**, 150 (2002).
 [7] T. Yefsah, A. T. Sommer, M. J. H. Ku, L. W. Cheuk, W. Ji, W. S. Bakr, and M. W. Zwierlein, [arXiv:1302.4736](https://arxiv.org/abs/1302.4736) [cond-mat.quant-gas].
 [8] Z. Dutton, M. Budde, C. Slowe, and L. H. Hall, *Science* **293**, 663 (2001).
 [9] M. A. Hofer, M. J. Ablowitz, I. Coddington, E. A. Cornell, P. Engels, and V. Schweikhard, *Phys. Rev. A* **74**, 023623 (2006).
 [10] J. A. Joseph, J. E. Thomas, M. Kulkarni, and A. G. Abanov, *Phys. Rev. Lett* **106**, 150401 (2011).
 [11] P. G. Kevrekidis, D. J. Frantzeskakis, and R. Carretero-Gonzalez, *Emergent Nonlinear Phenomena in Bose-Einstein Condensates* (Springer, Berlin, 2008).
 [12] A. Bulgac, Y. L. Luo, and K. J. Roche, *Phys. Rev. Lett* **108**, 150401 (2012).
 [13] F. Ancilotto, L. Salasnich, and F. Toigo, *Phys. Rev. A* **85**, 063612 (2012).
 [14] L. Salasnich, *Europhys. Lett* **96**, 40007 (2011).
 [15] E. Bettelheim and L. Glazman, *Phys. Rev. Lett* **109**, 260602 (2012).
 [16] I. V. Protopopov, D. B. Gutman, P. Schmitteckert, and A. D. Mirlin, *Phys. Rev. B* **7**, 045112 (2013).
 [17] J. J. Chang, P. Engels, and M. A. Hofer, *Phys. Rev. Lett* **101**, 170404 (2008).
 [18] S. Giorgini and S. Stringari, *Rev. Mod. Phys* **80**, 1215 (2008).
 [19] J. Carlson, S. Gandolfi, K. E. Schmidt, and S. Zhang, *Phys. Rev. A* **84**, 061602 (2011).
 [20] M. McNeil Forbes, S. Gandolfi, and A. Gezerlis, *Phys. Rev. Lett*.