Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Visco-elastic Dynamics of an Active Polar Dynamic System HARALD PLEINER, Max Planck Institute for Polymer Research, Mainz, Germany, DANIEL SVENSEK, Department of Physics, Faculty of Mathematics and Physics, University of Ljubljana, Ljubljana, Slovenia, HELMUT R. BRAND, Theoretische Physik III, Universität Bayreuth, Germany — We study the dynamics of systems with a polar dynamic preferred direction that are embedded in visco-elastic media. Examples include the pattern-forming growth of bacteria and molecular motors. Because the ordered state only exists dynamically, but not statically, the macroscopic variable of choice is the velocity of the active units. The passive visco-elastic medium is described by a relaxing strain tensor. We derive the macroscopic equations for such a system and discuss novel static, reversible and irreversible cross-couplings connected to this two-fluid (two-velocity) system. The dynamics is rather different compared to the case of passive, static polar order. In particular, we find a complicated normal mode structure that reflects the broken time-reversal symmetry due to the non-equilibrium situation, anisotropy of first sound and a possible second sound excitation due to the active velocity, and various manifestations of the visco-elastic relaxation. We discuss critically the role of the so-called active term in the stress tensor as well as the thermodynamically correct description of the hydrodynamic transport velocities.

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Date submitted: 27 Oct 2014 Electronic form version 1.4