Sound propagation in a uniform superfluid two-dimensional Bose gas

édouard Le Cerf* , Raphaël Saint-Jalm[1], Jean-Loup Ville[1], Monika Aidelsburger[2,3], Jérôme Beugnon[4], Sylvain Nascimbène[1,5], and Jean Dalibard[5,6]

[1]Laboratoire Kastler Brossel (LKB (Lhomond)) – Université Pierre et Marie Curie (UPMC) - Paris VI, CNRS : UMR8552, École normale supérieure [ENS] - Paris, Université Pierre et Marie Curie [UPMC] - Paris VI – 24 rue Lhomond, F-75231 Paris CEDEX 05, France

[2]Max-Planck-Institut für Quantenoptik – Germany

[3]Ludwig-Maximilians-Universität München – Germany

[4]Laboratoire Kastler Brossel (LKB) – Collège de France – France

[5]Collège de France (CDF) – Collège de France – 11 place Marcelin Berthelot F-75231 Paris Cedex 05, France

[6]Laboratoire Kastler Brossel (LKB) – Université Pierre et Marie Curie (UPMC) - Paris VI, CNRS : UMR8552, École normale supérieure [ENS] - Paris, Université Pierre et Marie Curie [UPMC] - Paris VI – 24 rue Lhomond, F-75231 Paris CEDEX 05, France

Abstract

In superfluid systems several sound modes can be excited, as for example first and second sound in
liquid helium. Here, we excite propagating and standing waves in a uniform two-dimensional Bose

gas and we characterize the propagation of sound in both the superfluid and normal regime. In the

superfluid phase, the measured speed of sound is well described by a two-fluid hydrodynamic model,

and the weak damping rate is well explained by the scattering with thermal excitations. In the
normal phase the sound becomes strongly damped due to a departure from hydrodynamic behavior.

*Speaker