GRAVITATIONAL RADIATION FROM THE EARLY UNIVERSE

Mark Hindmarsh\textsuperscript{1,2}, Stephan Huber\textsuperscript{2}, Kari Rummukainen\textsuperscript{1} and David Weir\textsuperscript{3}

\textsuperscript{1}Department of Physics and Helsinki Institute of physics, University of Helsinki, P.O. Box 64, 00014 University of Helsinki, Finland
\textsuperscript{2}Department of Physics and Astronomy, University of Sussex, Falmer, Brighton BN1 9QH, U.K.
\textsuperscript{3}Institute of Mathematics and Natural Sciences, University of Stavanger, 4036 Stavanger, Norway

email: kari.rummukainen@helsinki.fi

In the early Universe there are several processes which may generate observable gravitational radiation, such as inflation, cosmic strings or other topological defects, and first order phase transitions. The radiation may be observable in proposed future space-based detectors, in the first place the European eLISA satellite constellation \cite{1}, scheduled for launch in 2034. The gravitational radiation will provide an unprecedented direct view of the Universe at the time of their creation.

In order to understand the physics reach of these detectors it is of fundamental importance to know in detail how the gravitational radiation is generated. We have studied the generation of gravitational waves in cosmological first order phase transitions using large-scale numerical simulations \cite{2}. We have discovered that the dominant source of gravitational radiation are the acoustic waves generated during the transition – the “sound” of the transition. This mechanism has been hitherto unappreciated, and it can generate up to two orders of magnitude stronger radiation than earlier calculations have indicated. This significantly increases the discovery potential of the proposed detectors.

Figure 1: Snapshots of the fluid energy density during a cosmological phase transition. The generation of gravitational waves remains active long after the transition itself has completed.

\cite{1} eLISA Collaboration, P. A. Seoane et al., arXiv:1305.5720.