LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

LLNL-TR-410904

Technical Note: Description of Surface Tension as Implemented In LDEC-SPH Module

J. P. Morris

February 27, 2009

Disclaimer

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Technical Note: Description of Surface Tension as Implemented In LDEC-SPH Module

Joseph P. Morris

This brief report describes recent results obtained with the LDEC SPH module including the effects of surface tension. LDEC implements a quasi-incompressible approximation to the Navier-Stokes equations (Morris et al., 1997).

The author previously developed an approach to surface tension with SPH that calculated the curvature directly by taking the divergence of surface normals obtained from the gradient of a color function (Morris, 2000). In contrast, the implementation demonstrated here is based upon that developed by Tartakovsky and Meakin (2005) who introduced an additional force between the particles which results in the effect of surface tension. A similar method was also employed by Becker and Teschner (2007) who replaced the cosine based functional form developed by Tartakovsky and Meakin (2005) with a form based upon the SPH kernel function itself. These formulations do not accommodate a specified surface tension value, rather the effect of surface tension is an emergent feature and thus the techniques must be calibrated.

Figure 1 shows results of an initial simulation performed with the LDEC-SPH module in 2-D using the approach developed by Tartakovsky and Meakin (2005). A square volume of fluid is observed to transition to a circle due to the effects of surface tension. Due to being critically damped, this simulation proceeds directly to the circular stable state.

Future work will include following the same validation steps that Tartakovsky and Meakin (2005) used. That is, performing numerical experiments to determine the relationship between the parameter of the surface tension formulation and an equivalent effective surface tension value. We will also evaluate the alternative functional form promoted by Becker and Teschner (2007) to see if it provides improved robustness as claimed by those authors.

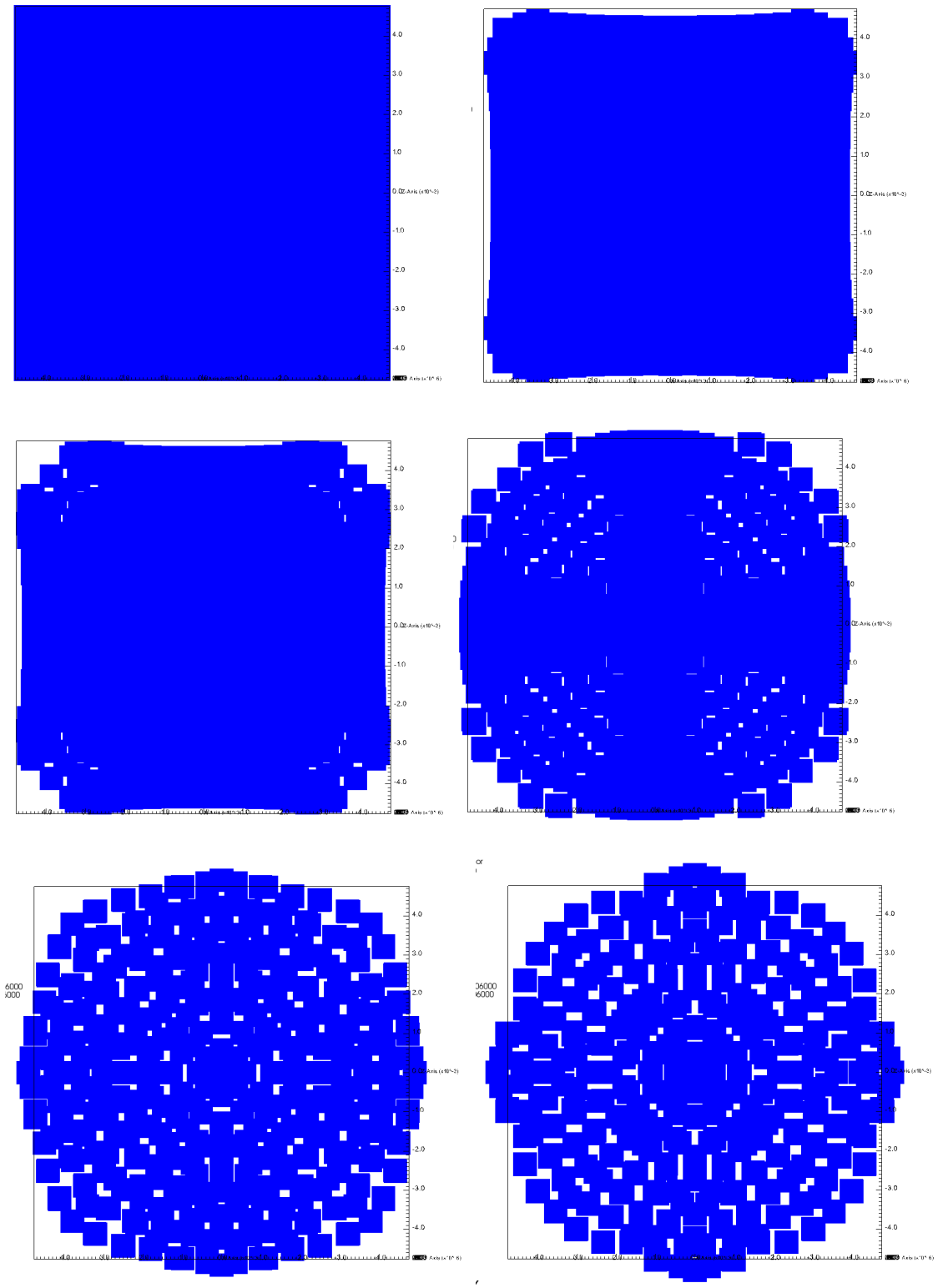

Figure 1: Evolution of a square region of fluid into a circle due to the influence of surface tension.

REFERENCES:

Tartakovsky A, Meakin, P. Modeling of surface tension and contact angles with smoothed particle hydrodynamics, PHYSICAL REVIEW E 72, 026301, 2005.

J. P. Morris, P. J. Fox, and Y. Zhu, J. Comput. Phys. 136, 214, 1997.

J. P. Morris, Int. J. Numer. Methods Fluids 33, 333, 2000.

Becker, M. and Teschner, M., Weakly compressible SPH for free surface flows, Eurographics/ ACM SIGGRAPH Symposium on Computer Animation (2007), pp. 1–8