

## **Hassan Aref**

### I. Vortex patterns

Abstract: In more complicated vortex flows with several degrees of freedom the only solutions to the equations of motion that we have correspond to spatially invariant patterns of one kind or another. These are often called "relative equilibria" to stress that the vortices retain the same relative positions even as the whole pattern may rotate or translate in space. The general survey lecture will address the phenomenology of such vortex patterns with excursions into adjacent subjects. It will touch on some of the analytical tools available.

### II. Mathematics of vortex patterns

Abstract: We will delve deeper into the mathematics of relative equilibria, particularly in the simplest case of point vortices. There are some interesting general results, and there are some delightful connections to other parts of mathematical physics. The lecture will introduce a few of the ideas and techniques that have been brought to bear on this problem.

Some useful references:

P. K. Newton & G. Chamoun, "Vortex lattice theory: A particle interaction perspective." *SIAM Review* 51 (2009) 501-542.

(doi: 10.1137/07068597X)

H. Aref, P. K. Newton, M. A. Stremler, T. Tokieda & D. L. Vainchtein, "Vortex crystals." *Advances in Applied Mechanics* 39 (2003)1-79.

(doi: 10.1016/S0065-2156(02)39001-X)

H. Aref, "Relative equilibria of point vortices and the fundamental theorem of algebra." *Proc. R. Soc. London A* **467** (published online, doi: **10.1098/rspa.2010.0580**)