Time-Dependent Superfluid Local Density Approximation –TDSLDA

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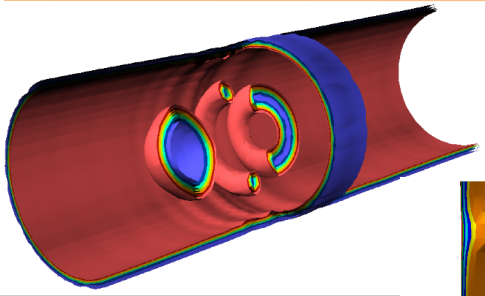
ASCR- SciDAC UNEDF Application Partnership Highlight ***(www.unedf.org)***

Objectives

- **Develop a scalable software implementation of the time-dependent density functional theory extended to fermionic superfluid systems**
- **Apply the code to condensed matter and nuclear phenomena (low-energy excitations and reactions, nuclear fission, neutron stars) for the UNEDF project**

Impact

- **Scalable, accurate, stable, and fast time-dependent software to solve hundreds of thousands of coupled nonlinear 3D PDEs for long time intervals and large spatial simulation volumes**
- **TDSLDA provides a comprehensive, microscopically consistent approach to address qualitatively new theoretical questions in nuclear and condensed matter physics**



The first microscopic calculation of vortex rings generation (above) and of vortex line recombination (right) in a fermionic superfluid

Progress / Accomplishments FY10

- *Generation and Dynamics of Quantized Vortices in a Unitary Fermi Superfluid*, Bulgac et al, http://arxiv.org/abs/1011.5999
  - Correctly describes superfluid to normal phase dynamics, generation and dynamics of quantized vortices, predicts a qualitatively new phenomenon - the superflow at supercritical Landau velocities
- Fast, scalable I/O for TB of data, flexible checkpoint restart capability
- 220,000 cores on JaguarPF , ~65 million CPU hours in 2010 to simulate superfluid and nuclear dynamics