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Final Report: Alpha Channeling in Open-System Magnetic Devices
DOE/OFES #DE-SC0000736, (formerly DOE/OFES #DE-FG02-06ER54851)
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The Grant DE-SC0000736, *Alpha Channeling in Open-System Magnetic Devices,* is a continuation of the Grant DE-FG02-06ER54851, *Alpha Channeling in Mirror Machines*. In publications funded by DE-SC0000736, the grant DE-FG02-06ER54851 was actually credited.

The key results obtained under Grant DE-SC0000736, *Alpha Channeling in Open-System Magnetic Devices,* appear in a series of publications [1-4]. The earlier effort under DE-FG02-06ER54851 was the subject of a previous Final Report. The theme of this later effort has been unusual confinement effects, or de-confinement effects, in open-field magnetic confinement devices. First the possibilities in losing axisymmetry were explored [1]. Then a number of issues in rotating plasma were addressed [2-3]. Most importantly, a spinoff application to plasma separations was recognized [4] which also resulted in a provisional patent application [5]. (That provisional patent application, however, was not pursued further.)

Alpha channeling entails injecting waves into magnetically confined plasma to release energy from one particular ion while ejecting that ion. The ejection of the ion is actually a concomitant effect in releasing energy from the ion to the wave. In rotating plasma, there is the opportunity to store the energy in a radial electric field rather than in waves. In other words, the ejected alpha particle loses its energy to the radial potential, which in turn produces plasma rotation. This is a very useful effect, since producing radial electric fields by other means are technologically more difficult. In fact, one can heat ions, and then eject them, to produce the desired radial field. In each case, there is a separation effect of different ions, which generalizes the original alpha-channeling concept of separating alpha ash from hydrogen. In a further generalization of the separation concept, a double-well filter [4-5] represents a new way to produce high-throughput separations of ions, potentially useful for nuclear waste remediation.

[1] R. Gueroult and N. J. Fisch,
Particle deconfinement in a bent magnetic mirror,
Physics of Plasma **19**, 112105 (August, 2012).

[2] A. Fruchtman, R. Gueroult, and N. J. Fisch,
Rigid-body rotation of an electron cloud in divergent magnetic fields,
Physics of Plasma **20**, 073502 (July, 2013).

[3] R. Gueroult, A. Fruchtman and N. J. Fisch,
Tendency of a rotating electron plasma to approach the Brillouin limit,
Physics of Plasma **20**, 073505 (July, 2013).

[4] R. Gueroult, J. M. Rax, and N. J. Fisch,
The double-well mass filter,
Physics of Plasma **21**, 020701 (February, 2014).

[5] *The double-well mass filter,* Inventors: R. Gueroult, J. M. Rax, and N. J. Fisch,
US Provisional Patent Application; filed February 10, 2014.