A new class of magnetic confinement device in the shape of a knot

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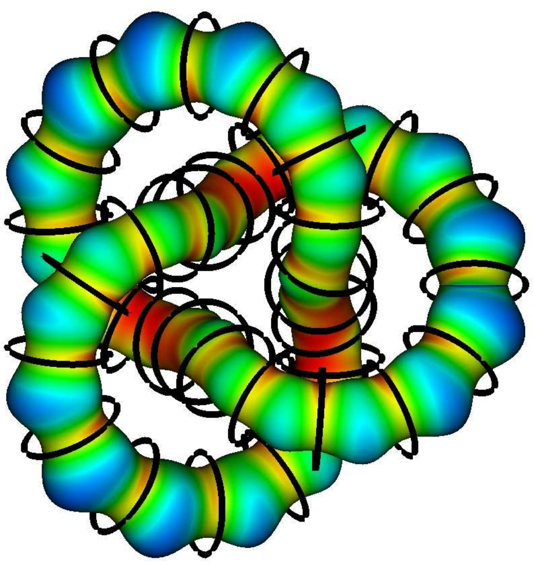
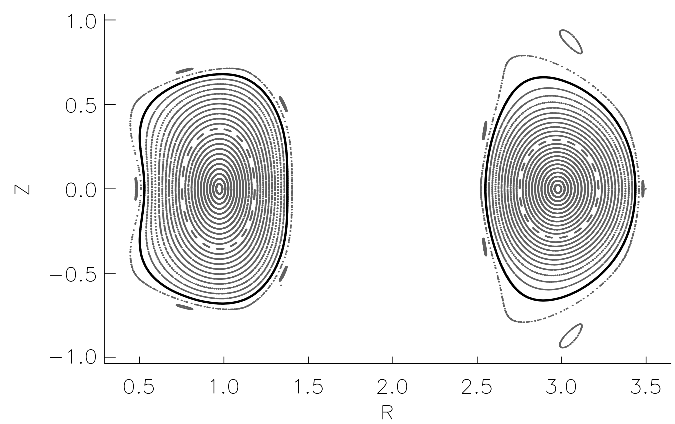
The principle of magnetically confining a plasma exploits the fact that the motion of charged particles in a strong magnetic field consists of a free-streaming motion parallel to the field combined with a small, perpendicular gyration. To prevent so-called "end-losses", modern experiments "close" the magnetic field by constructing a topological torus. At the most primitive level, a magnetic confinement device must have a large volume of space filled with toroidal, magnetic flux surfaces; on which the magnetic fieldlines must rotate in the poloidal direction while they rotate in the toroidal direction in order to cancel the particle drifts caused by an inhomogeneity in the field strength.

Joining the ends of a cylinder together to form a tokamak or conventional stellarator is not the only option for closing the magnetic field to prevent end-losses. The magnetic axes of rotationally symmetric tokamaks are circles, and those of conventional stellarators are smoothly deformable into circles. There is another class of plasma magnetic confinement device that (i) is closed, in the sense that magnetic fieldlines wrap around on flux-surfaces that enclose a finite volume; and (ii) has significant rotational-transform, even in the absence of plasma current; and (iii) that has a magnetic axis that is *not* smoothly deformable into a circle.

We introduce the *"knotatron"*, a magnetic confinement device with the magnetic axis in the shape of a knot [Hudson, Startsev & Feibush, *Phys. Plasmas, 2014*]. Various examples of knotatrons will be presented. A trefoil-knotatron is shown below, in which 36 circular coils produce a field with the magnetic axis in the shape of a trefoil knot. This coil configuration produces a large volume filled with magnetic surfaces, as shown in the accompanying Poincaré plot, with significant rotational-transform.





[Requesting an oral presentation.]