ENCAPSULATING MAGNETIC FIELDS FOR PLASMA CONFINEMENT

TECHNICAL FIELD

[1] This disclosure generally relates to fusion reactors and more specifically to encapsulating magnetic fields for plasma confinement.

BACKGROUND

[2] Fusion power is power that is generated by a nuclear fusion process in which two or more atomic nuclei collide at very high speed and join to form a new type of atomic nucleus. A fusion reactor is a device that produces fusion power by confining and controlling plasma. Typical fusion reactors are large, complex, and cannot be mounted on a vehicle.

SUMMARY OF PARTICULAR EMBODIMENTS

[2a] According to a first aspect of the present invention, there is provided a fusion reactor comprising:

an enclosure comprising a centerline running down a center axis of the enclosure;

an open-field magnetic system comprising one or more internal magnetic coils suspended within the enclosure and centered on the centerline, wherein the one or more internal magnetic coils each have a radius configured to balance the relative field strength between a plurality of point cusps and a plurality of ring cusps; and

a plurality of encapsulating magnetic coils centered on the centerline, the plurality of encapsulating magnetic coils having a larger diameter than the one or more internal magnetic coils of the open-field magnetic system, the plurality of encapsulating magnetic coils operable to form a magnetosphere around the open-field magnetic system;

wherein the open-field magnetic system and the plurality of encapsulating magnetic coils are operable, when supplied

with electrical currents, to form magnetic fields for confining plasma within the enclosure, and

wherein the plurality of point cusps includes a first point cusp located proximate a first end of the enclosure and a second point cusp proximate a second end of the enclosure; and

wherein the plurality of ring cusps includes a first ring cusp located between a first one of the one or more internal magnetic coils and the first end of the enclosure and a second ring cusp located between the first one of the one or more internal magnetic coils and the second end of the enclosure.

[2b] There is also provided a fusion reactor comprising:

an enclosure;

an open-field magnetic system comprising one or more internal magnetic coils suspended within the enclosure; and

one or more encapsulating magnetic coils coaxial with the one or more internal magnetic coils of the open-field magnetic system, the one or more encapsulating magnetic coils operable to form a magnetosphere around the open-field magnetic system;

wherein the open-field magnetic system and the one or more encapsulating magnetic coils are operable, when supplied with electrical currents, to form magnetic fields for confining plasma within the enclosure, and

wherein the one or more of encapsulating magnetic coils are located within the enclosure.

[2c] According to a second aspect of the present invention, there is provided a fusion reactor comprising:

an open-field magnetic system comprising one or more internal magnetic coils suspended within an enclosure, wherein the one or more internal magnetic coils each have a radius configured to balance the relative field strength between a plurality of point cusps and a plurality of ring cusps; and

one or more encapsulating magnetic coils coaxial with the one or more internal magnetic coils of the open-field magnetic system, the one or more encapsulating magnetic coils operable to form a magnetosphere around the open-field magnetic system;

wherein the open-field magnetic system and the one or more encapsulating magnetic coils are operable, when supplied with electrical currents, to form magnetic fields for confining plasma within the enclosure, and

wherein the plurality of point cusps includes a first point cusp located proximate a first end of the enclosure and a second point cusp proximate a second end of the enclosure; and

wherein the plurality of ring cusps includes a first ring cusp located between a first one of the one or more internal magnetic coils and the first end of the enclosure and a second ring cusp located between the first one of the one or more internal magnetic coils and the second end of the enclosure.

[3] According to one embodiment, a fusion reactor includes an enclosure, an open-field magnetic system comprising one or more internal magnetic coils suspended within the enclosure, and one or more encapsulating magnetic coils coaxial with the one or more internal magnetic coils of the open-field magnetic system. The one or more encapsulating magnetic coils form a magnetosphere around the open-field magnetic system. The open-field magnetic system and the one or more encapsulating magnetic coils, when supplied with electrical currents, form magnetic fields for confining plasma within the enclosure.

[4] Technical advantages of certain embodiments may include providing a compact fusion reactor that is less complex and less expensive to build than typical fusion reactors. Some embodiments may provide a fusion reactor that

WHAT IS CLAIMED IS:

1. A fusion reactor comprising:

an enclosure comprising a centerline running down a center axis of the enclosure;

an open-field magnetic system comprising one or more internal magnetic coils suspended within the enclosure and centered on the centerline, wherein the one or more internal magnetic coils each have a radius configured to balance the relative field strength between a plurality of point cusps and a plurality of ring cusps; and

a plurality of encapsulating magnetic coils centered on the centerline, the plurality of encapsulating magnetic coils having a larger diameter than the one or more internal magnetic coils of the open-field magnetic system, the plurality of encapsulating magnetic coils operable to form a magnetosphere around the open-field magnetic system;

wherein the open-field magnetic system and the plurality of encapsulating magnetic coils are operable, when supplied with electrical currents, to form magnetic fields for confining plasma within the enclosure, and

wherein the plurality of point cusps includes a first point cusp located proximate a first end of the enclosure and a second point cusp proximate a second end of the enclosure; and

wherein the plurality of ring cusps includes a first ring cusp located between a first one of the one or more internal magnetic coils and the first end of the enclosure and a second ring cusp located between the first one of the one or more internal magnetic coils and the second end of the enclosure.

2. The fusion reactor of Claim 1, wherein the plurality of encapsulating magnetic coils are operable to preserve the magnetohydrodynamic (MHD) stability of the fusion reactor by maintaining a magnetic wall that prevents the plasma from expanding.

3. The fusion reactor of Claim 1, wherein the one or more internal coils of the open-field magnetic system are toroidal in shape.

4. The fusion reactor of Claim 1, wherein the enclosure is substantially cylindrical in shape.

5. The fusion reactor of Claim 1, wherein the open-field magnetic system comprises a dipole system.

6. The fusion reactor of Claim 1, wherein the open-field magnetic system comprises a magnetic mirror system.

7. The fusion reactor of Claim 1, wherein the open-field magnetic system comprises a cusp system.

8. A fusion reactor comprising:

an open-field magnetic system comprising one or more internal magnetic coils suspended within an enclosure, wherein the one or more internal magnetic coils each have a radius configured to balance the relative field strength between a plurality of point cusps and a plurality of ring cusps; and

one or more encapsulating magnetic coils coaxial with the one or more internal magnetic coils of the open-field magnetic system, the one or more encapsulating magnetic coils operable to form a magnetosphere around the open-field magnetic system; wherein the open-field magnetic system and the one or more encapsulating magnetic coils are operable, when supplied with electrical currents, to form magnetic fields for confining plasma within the enclosure, and

wherein the plurality of point cusps includes a first point cusp located proximate a first end of the enclosure and a second point cusp proximate a second end of the enclosure; and

wherein the plurality of ring cusps includes a first ring cusp located between a first one of the one or more internal magnetic coils and the first end of the enclosure and a second ring cusp located between the first one of the one or more internal magnetic coils and the second end of the enclosure.

9. The fusion reactor of Claim 8, wherein the one or more encapsulating magnetic coils have a larger diameter than the one or more internal magnetic coils of the open-field magnetic system.

10. The fusion reactor of Claim 8, wherein the open-field magnetic system comprises a dipole system.

11. The fusion reactor of Claim 8, wherein the open-field magnetic system comprises a magnetic mirror system.

12. The fusion reactor of Claim 8, wherein the open-field magnetic system comprises a cusp system.

13. The fusion reactor of Claim 7, wherein the magnetic mirror system comprises two mirror magnetic coils and wherein a direction of current in the plurality of encapsulating magnetic coils and the two mirror magnetic coils is the same and wherein a direction of current in the one or more internal magnetic coils is opposite the direction of current in the plurality of encapsulating magnetic coils and the two mirror magnetic coils.

14. The fusion reactor of Claim 1, wherein the one or more internal magnetic coils are surrounded by, and shielded from, the plasma and suspended within the enclosure by at least one support.

15. The fusion reactor of Claim 1, wherein the open-field magnetic system comprises:

a center magnetic coil centered on the centerline and located proximate to a midpoint of the enclosure; and

first and second mirror magnetic coils disposed on opposite sides of the center magnetic coil.

16. The fusion reactor of Claim 6, wherein the magnetic mirror system comprises two mirror magnetic coils and wherein a direction of current in the one or more encapsulating magnetic coils and the two mirror magnetic coils is the same and wherein a direction of current in the one or more internal magnetic coils is opposite the direction of current in the one or more encapsulating magnetic coils and the two mirror magnetic coils.

17. The fusion reactor of Claim 8, wherein a direction of current in the one or more encapsulating magnetic coils is opposite the direction of current in the one or more internal magnetic coils.

18. The fusion reactor of Claim 8, wherein the open-field magnetic system comprises two internal magnetic coils and wherein the two internal magnetic coils are surrounded by, and shielded from, the plasma and suspended within the enclosure by at least one support.

19. The fusion reactor of Claim 8, wherein the open-field magnetic system comprises:

a center magnetic coil centered on a centerline and located proximate to a midpoint of the enclosure; and

first and second mirror magnetic coils disposed on opposite sides of the center magnetic coil.