Preliminary Results for Experiment at the Wisconsin Plasma Physics Laboratory (WIPPL)

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What are Interplanetary Coronal Mass Ejections (ICMEs) and why are they important?

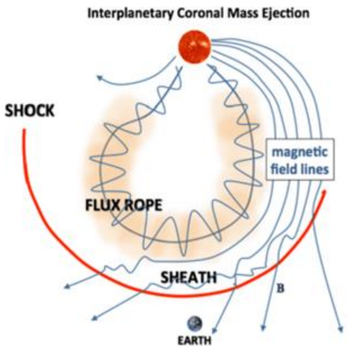
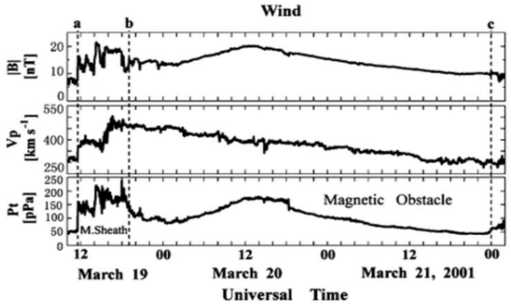


Diagram of an ICME heading towards Earth [1].

- ICMEs are the source of geomagnetic storms
- Geomagnetic storms caused by the sun can damage human electrical systems

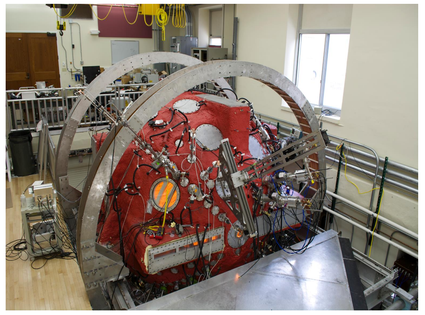
ICMEs have distinct regions that are identifiable in satellite data [2]



- Shock: (Marked by dotted line “a”) Sudden increase in magnetic field, pressure, and particle velocity
- Sheath: (Region between dotted lines “a” and “b”) Region of increased pressure, temperature and erratic magnetic field
- Ejecta: (Region between dotted lines “b” and “c”) Region with smooth magnetic field and decreasing temperature and particle velocity

We sent a scaled ICME through a background plasma to act as the interplanetary medium

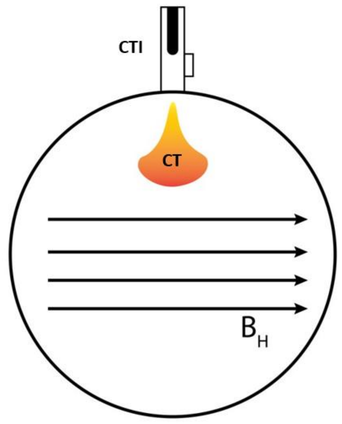
- A Compact Torus (CT) of plasma is sent through a perpendicularly magnetized plasma
- We control the background plasma parameters to scale the experiment appropriately



The Big Red Ball (BRB) equipped with Helmholtz coils

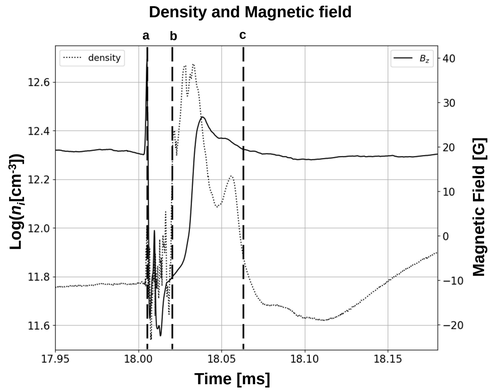
We used magnetic and temperature probes to diagnose our experiment

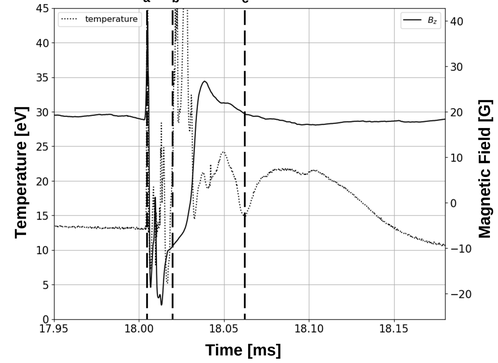
- B-dot probe array with 90° bend to measure a cross section of the experiment
- B-dot probe array that points radially inward to measure speeds of magnetic disturbances
- Langmuir probe to measure temperature and density



Schematic of the experimental setup inside the BRB.
CTI = Compact Torus Injector, the apparatus that launches the scaled ICME.
CT = Compact Torus, the plasma ejecta of the scaled ICME.
B_H is the back- ground magnetic field provided by the Helmholtz coils.

Time resolved data indicates recreation of zones consistent with ICME





- In data received from the Te probe and the Hook probe, there are distinct regions.
- These regions mark the shock, sheath, and ejecta of our scaled ICME.

Conclusion

ICME events are important to study in controlled environments. To study them, we injected a compact torus into a background plasma. We diagnosed the experiment using B-dot probes and a Langmuir probe. The data collected shows the shock, sheath, and ejecta. These results allow us to further research solar phenomena. Future experiments will explore the effects of a magnetic field gradient on a scaled ICME.

References:
- [1] - E. K. J. Kilpua, A. Balogh, R. von Steiger, and Y. D. Liu, Geoeffective properties of solar transients and stream interaction regions - space science reviews, Sep. 2017.
- [2] - L. Jian, C. Russell, J. Luhmann, and R. Skoug, “Properties of interplanetary coronal mass ejections at one au during 1995–2004,” Solar Physics, vol. 239, no. 1, pp. 393– 436, 2006.

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