**Helicon Sources for High Beta Space Physics Experiments**

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**Space in the Laboratory?**

In 1994, construction began on the world’s first steady-state, high beta, space-relevant plasma physics facility. The objective was to create reproducible, steady-state plasma at beta large enough that space phenomena could be investigated under well-controlled laboratory conditions, and to study the relationship between ion temperature anisotropy and electromagnetic instabilities driven by electron heat flux. To achieve these goals, plasma density and ion temperature were reduced to values seen in the magnetosheath.

The facility, called LEIA (Large Experiment in Astrophysics and Terrestrial Physics), was designed to investigate space physics phenomena in a laboratory setting. The facility provided a controlled environment that allowed scientists to study phenomena similar to those observed in space.

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**Limits on Ion Temperature Anisotropy in the Magnetosphere**

Observations from AMPTE/IRM (1985) in both the magnetosheath and plasma sheet boundaries indicate an inverse correlation of ion temperature anisotropy and parallel ion beta. Both ion temperature anisotropy and electromagnetic instabilities driven by electron heat fluxes suggest that the magnetosheath is a region where beta is large enough that space phenomena could be investigated under well-controlled laboratory conditions.

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**Theoretical Predictions Based on the Threshold for Ion Cyclotron Instability**

Phan et al., 1994

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**Ion Temperature Anisotropy Observed**

Ion temperature anisotropy observed during the space environment. The data for which the ion-neutral and ion-ion collisions occur are shown in the space environment.

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**Transverse, Low Frequency Electromagnetic Waves Observed**

Transverse, low frequency waves are observed during periods of high and low temperature anisotropy. Wavenumber measurements yield increasing beta.

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**Wavenumbers and Polarization of Waves Consistent with Theory Predictions**

In normalizing electromagnetic waves, the wavenumber ($k$) and the magnetic field ($B$) are used. The polarization spectra of the waves (solid and dashed lines) are consistent with the theoretical predictions.

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**Summary**

- Steady-state plasmas with large ion temperature anisotropies generated in LEIA
- Ion temperature anisotropy scales inversely with ion beta in a manner consistent with space observations and theory.
- Low frequency electromagnetic waves observed for plasmas with large ion temperature anisotropies and at large ion betas.
- Wavenumber and polarization of low frequency waves consistent with expectations for Alfvén Ion Cyclotron Instability.