



# Bow shock upstream and downstream waves

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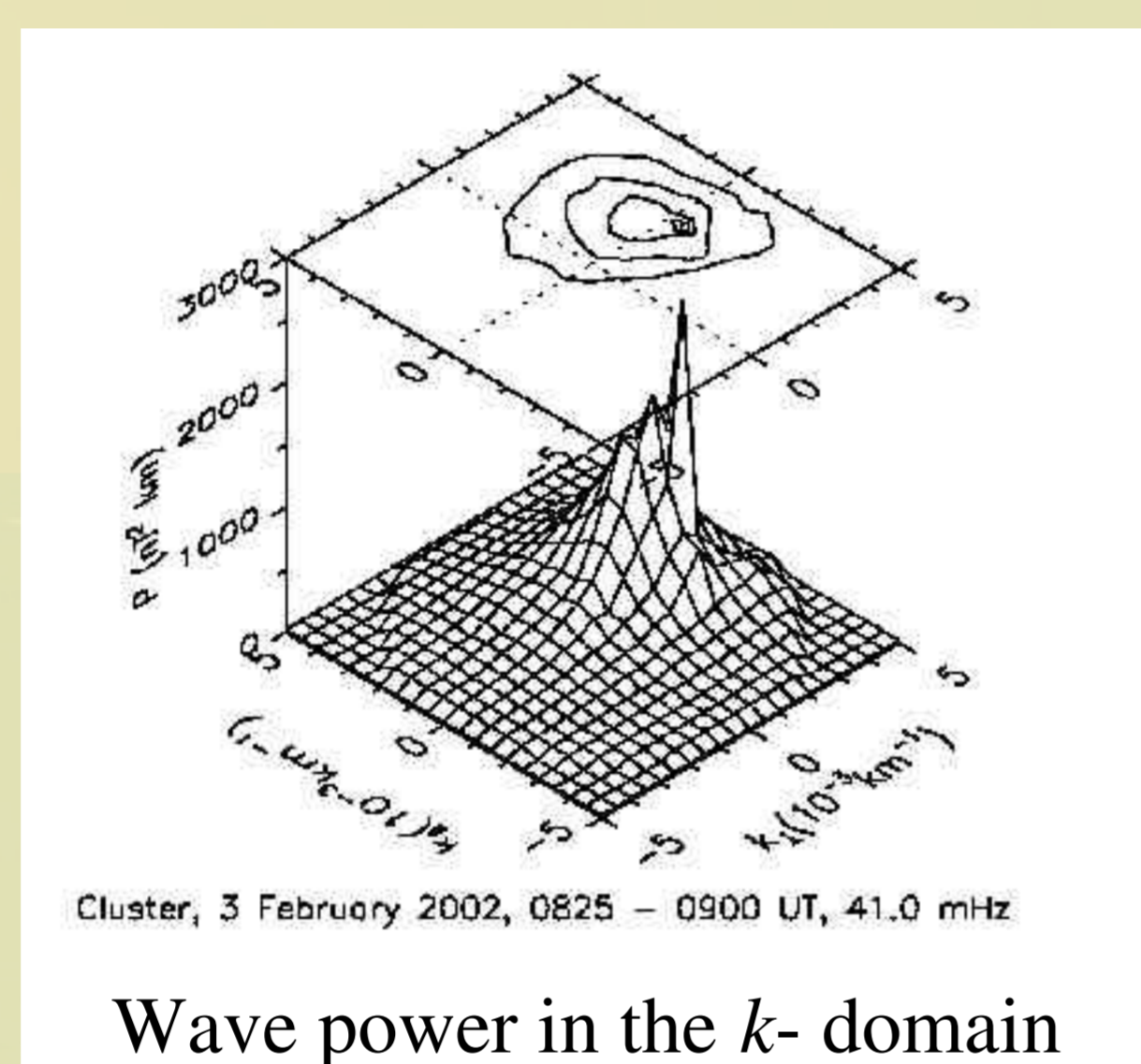
Bow shock in the Orion nebula (M42, image taken by the Hubble Space Telescope).

## Abstract

Wave vector determination from multi-point measurements leads to a number of powerful wave analysis methods. We present wave modes and their propagation patterns upstream and downstream of the Earth's bow shock.

## [1] Motivation

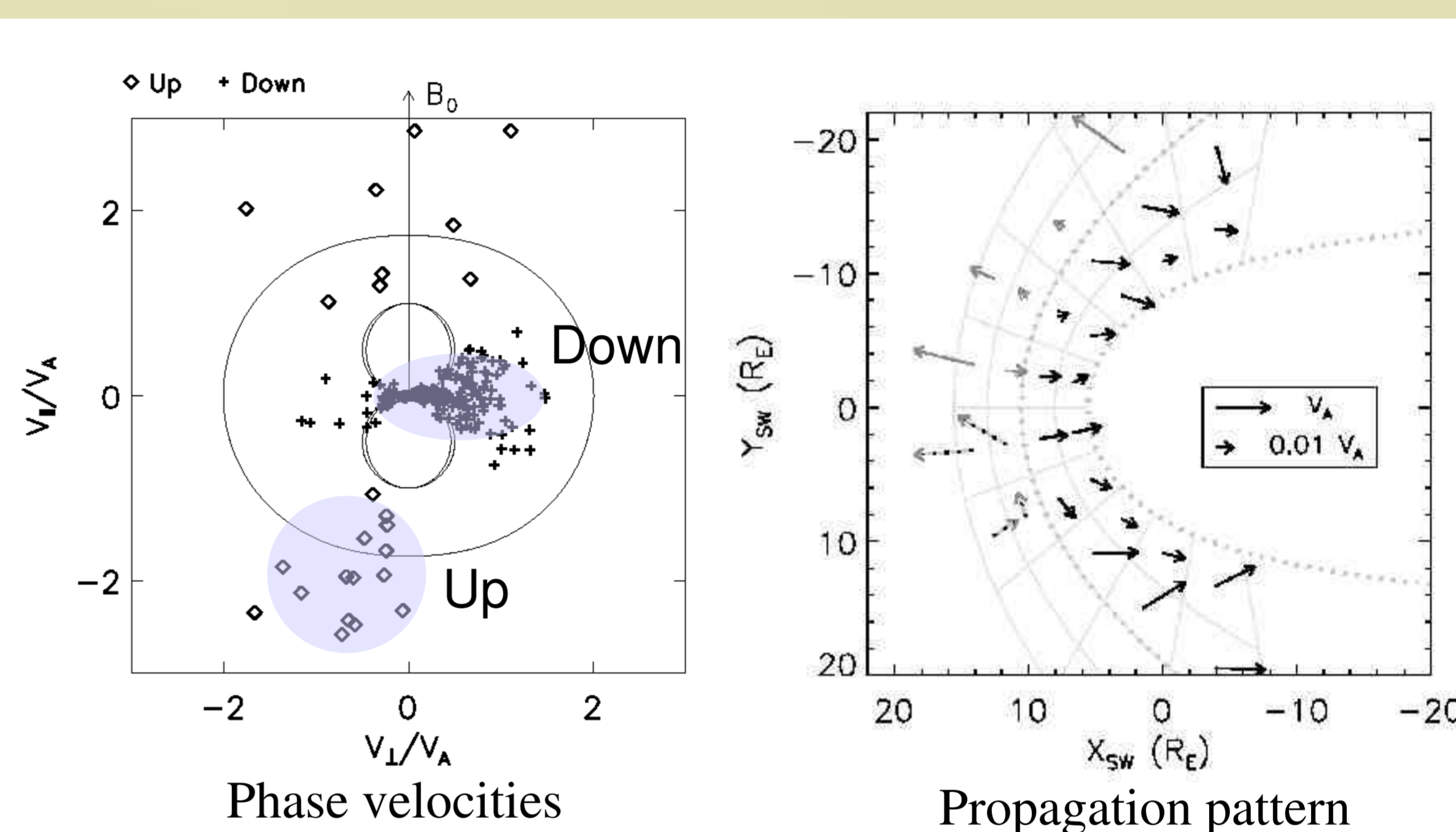
Determining wave vectors in space is not easy. But using four-point measurements made by Cluster s/c, it is at last possible to determine wave vectors, and hence wave modes and their propagation patterns.



## [3] Statistics

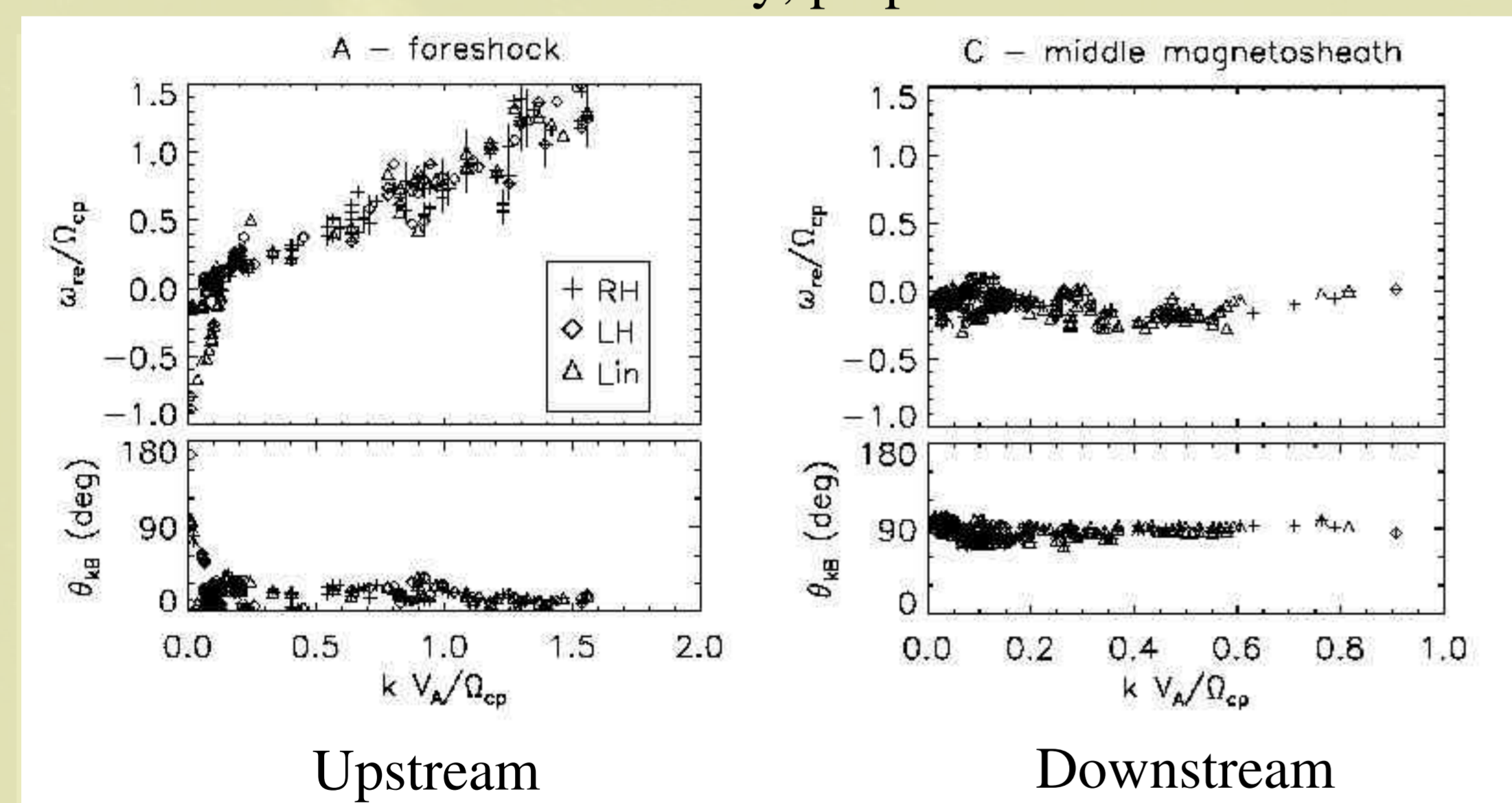
Phase velocities, propagation directions investigated for 100 upstream waves and 400 downstream waves.

- [Results] - Up: fast modes toward upstream.
- Down: mirror modes toward the magnetopause.



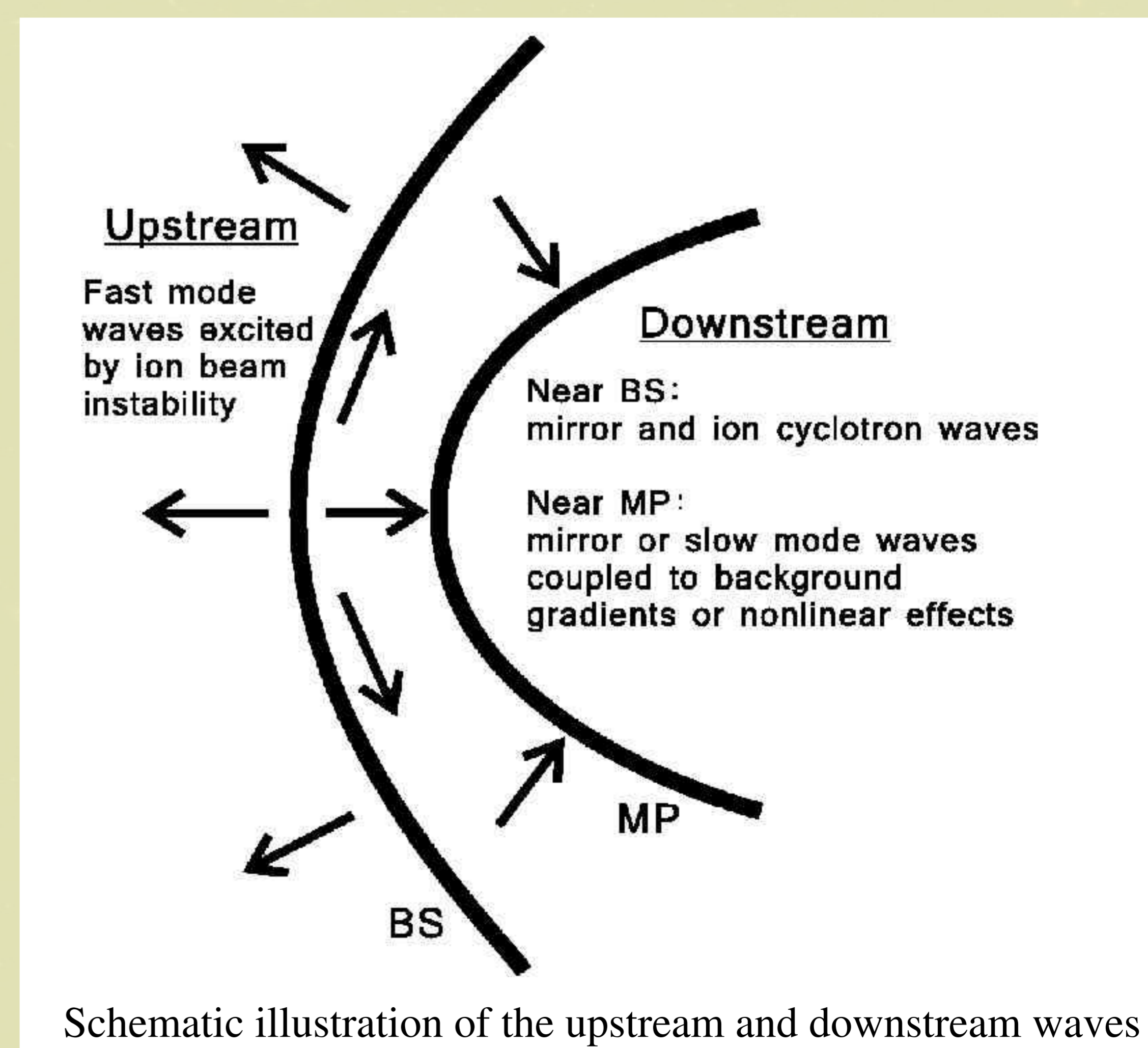
## [2] Dispersion curves

- Upstream: ion beam instability, parallel to the magnetic field.
- Downstream: mirror instability, perpendicular direction.



## [4] Conclusion

Ion reflection and temperature anisotropy are the source of the waves. Their propagation is divergent at the shock.



And ...

Turbulence spectra can also be determined!

