

Bow shock

As first proposed by Axford (1962) and Kellogg (1962), all **planetary bodies** having either a **magnetosphere** or a highly conducting **ionosphere** have also a bow **shock** associated with the deflection of the **solar wind** around them. This shock wave develops because the information needed to deflect the solar wind **plasma** around the obstacle travels at a velocity that is less than that of the solar wind flow. In general three **waves** are needed:

- slow magnetosonic wave
- intermediate wave
- fast magnetosonic wave

It is the last, fast magnetosonic wave that creates the bow shock also in front of the **Earth**'s magnetosphere. The other two waves are present in the **magnetosheath**.

In the upstream region, i.e., in front of the bow shock, is the so-called **foreshock region**. This region is important for the magnetospheric physics because of a wealth of wave activity that can be found inside of it, and because it creates, together with the most typical **IMF** direction close to the inner planets, a strong **dusk-dawn asymmetry** around the **magnetopause** (upstream foreshock in the dawn side is much larger than the downstream foreshock in the dusk side).

The waves in the foreshock region are coming from several sources:

- Some of the waves are generated in the bow shock and propagate upstream.
- Other waves are generated by electrons and ions accelerated at the bow shock and reflected back into the solar wind or leaked from the magnetosheath back upstream. These backstreaming particles generate waves through various **instabilities** and these waves are then convected with the solar wind flow toward the shock.
- Still other waves originate as newly created ions scatter and thermalize both in the extended coronas surrounding comets and in the exospheres of unmagnetized planets.

For example, the compressional **ULF** waves observed in the foreshocks of several planets are due to backstreaming ions. The frequency of these waves is controlled by the strength of the IMF, and in Earth's case they are labelled as **Pc 3** pulsations with periods about 30-40 s.

References

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