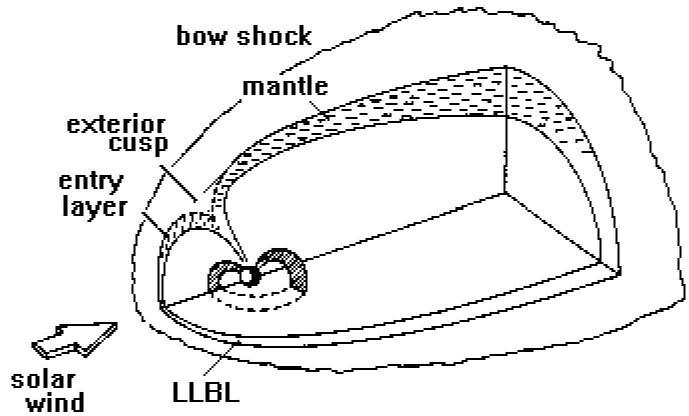
# Magnetospheric boundary layer

## Introduction

Magnetospheric boundary layer is a region close to the Earth's magnetopause in which magnetosheath plasma has strong influence. It can be divided into four parts:

1. Plasma mantle
2. Entry layer
3. Exterior cusps
4. Low-latitude boundary layer, LLBL




However, some researchers don't define the entry layer at all as a separate region. A n additional boundary called the **free-f low boundary** has been suggested to exists between the exterior cusp and the magnetosheath (this is the boundary that is often plotted as a dashed line in schematic figures of the magnetosphere).

Boundary layer is a very special region, not only because of the presence of magnetosheath plasma, but also because of the still uncertain topology. Also the mapping of the boundary layer regions to low altitude is not quite certain yet, although it is clear that these spatially vast regions map into a very limited region around the low altitude cusps. The mapping can be studied either by using advanced magnetic field models, or by low-altitude measurements of

- charged-particle precipitation
- visible auroral emissions
- geomagnetic pulsations
- correlation between optical emissions and geomagnetic pulsations
- field-aligned currents
- VLF signal characteristics and ionospheric absorption of cosmic noise
- incoherent scatter radar observations
- coherent HF radar backscatter

Charged-particle precipitation characteristics seem to be the best (low-altitude) means to categorize the boundary layers. Dayside auroral precipitation from these regions is responsible for the daytime zone of soft precipitation, or the cusp/cleft precipitation.

The recent loss of Cluster satellites was a bad blow to the in situ study of the Earth's boundary regions.

## Plasma mantle

The plasma mantle was first defined by Rosenbauer et al. (1975). It

- covers much of the high-latitude magnetosphere, extending poleward of the cusp region
- de-energized magnetosheath plasma
  - densities: few times 0.01 - 1 cm^-3
  - temperatures: about 100 eV
  - tailward flow velocities: 100-200 km/s
- region of the so-called mantle current and discrete auroras
- the density and energy often decrease when moving inward from the magnetosheath towards the magnetosphere (velocity filter effect, see the figure below); at low-altitude this creates an energy-latitude dispersion
- generally thicker for southward than northward IMF Bz (see solar wind)

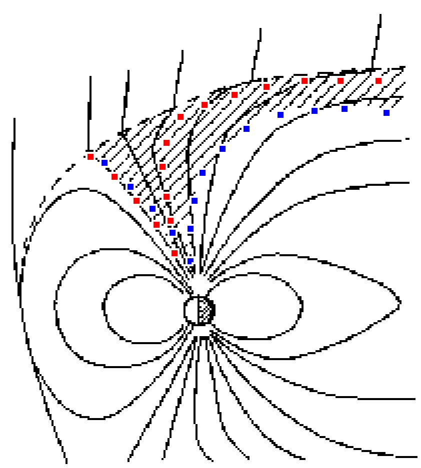


Figure: *Formation of the plasma mantle. Low-energy ions (blue) take longer to mirror from the ionosphere than do higher energy ions (red), and are thus convected further across field lines, giving decreasing energy and density with deeper penetration into the mantle (towards the magnetosphere).*

## Entry layer

The entry layer was first defined by Haerendel and Paschmann (1975) and Paschmann et al. (1976). It

- connected to the equatorward edge of the cusp region

- plasma density almost as high as in the magnetosheath
- generally lacking antisunward flow
- BUT: does it really exists?

## Exterior cusp

- region of hot stagnant magnetosheath plasma at the high altitude cusp

## Low-latitude boundary layer

- low-latitude boundary layer maps to the "cleft" at low altitudes.

## References


- Haerendel, G., and G. Paschmann, Entry of solar wind plasma into the magnetosphere, in Physics of the Hot Plasma in the Magnetosphere, ed. B. Hultqvist and L. Stenflo, p. 23, Plenum, New York, 1975.
- Paschmann, G., G. Haerendel, N. Sckopke, H. Rosenbauer, and P. C. Hedgecock, Plasma and magnetic field characteristics of the distant polar cusp near local noon: The entry layer, J. Geophys. Res., 81, 2883-, 1976.
- Rosenbauer, H., H. Grunmwaldt, M. D. Montgomery, G. Paschmann, and N. Sckopke, Heos 2 plasma observations in the distant polar magnetosphere: The plasma mantle, J. Geophys. Res., 80, 2723-, 1975.