# Toward full-automatic FLR identification and density estimation from SuperDARN VLOS data to identify magnetospheric regions

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Where the frequency of waves coming into the magnetosphere matches the eigenfrequency of a geomagnetic field line, which runs through the ground, the ionosphere, and the magnetosphere, FLR (field-line resonance) can cause the eigen-oscillations of the field line. The FLR-generated eigen-oscillation can be identified from the combination of the maximum in its power and the steepest change in its phase at its eigen-frequency (called the FLR frequency below). From thus identified FLR frequency one can estimate the density along the magnetic field line, because, in a simplified expression, ‘heavier’ field line oscillates more slowly.

Since the pulsations oscillate the ionospheric plasma, too, there could exist cases in which SuperDARN radars monitor the two-dimensional (2D) distribution of the FLR frequency, from which we can estimate 2D plasma-density distribution on the magnetospheric equatorial plane, including the location of the plasmapause. However, visual identification of the FLR in the SuperDARN VLOS (Velocity along the Line of Sight) data is time-consuming, and the visual identification could miss FLR events superposed by non-FLR oscillations of VLOS. In addition, there are lots of VLOS data to be analyzed. Thus, we started developing computer codes to automatically identify the FLR.

We have so far developed a set of computer codes to automatically identify the FLR for a beam of a radar by using the amplitude-ratio method and the cross-phase methods; these methods cancel out the superposed perturbations by dividing the data from a Range Gate (RG) by the data from a nearby RG along the same beam, since the FLR frequency tends to depend on the latitude more strongly than the superposed perturbations. Another advantage of applying these methods to the SuperDARN VLOS data is that we can choose any pair of RGs (along the same beam) with different distances, and thus can identify what distance is the best to identify the FLR. This distance reflects the resonance width, which is an important quantity reflecting the diffusion and dissipation of the FLR energy. This set of codes succeeded in identifying FLR events which we had visually identified in a few beams of a few radars by examining the raw amplitude and phase distribution along the beams.

We are now developing a code which unifies the above-stated set of codes so that it can be applied to VLOS data of all the beams of a radar at once. By using the code we expect to identify much more FLR events than by visual identification; the automatically identified FLR events would include events simultaneously observed at several locations by several radars, increasing the possibility of monitoring the 2D distributions of plasma density distribution on the magnetospheric equatorial plane and identify magnetospheric regions.