Computer Simulations on Single-Spacecraft Interferometry Technique Using Monopole Electric Field Sensors

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One of the most important parameters of plasma waves in space is phase velocities. The interferometry technique is a method to obtain phase velocities through spacecraft observation. The interferometry technique by single spacecraft often uses electric field sensors as monopoles instead of dipoles. Waveforms picked up by two monopole electric field sensors enable us to identify the phase difference at the two observation points on each element of the sensor. From the phase difference of waveforms and the distance between the observation points, the phase velocity can be calculated. The problem here is the uncertainties in the distance because the distance depends on the types of electric field sensors. Furthermore, the existence of spacecraft bodies and solar paddles could distort the electric wavefront. Evaluations based on realistic models of plasma environments including spacecraft bodies are important in getting precise phase velocities from observations. In this study, we use the full-PIC simulation to evaluate the interferometry technique and determine the equivalent length L_{eq}. To simulate electric field sensors in PIC simulation, we introduce a pair of two conductive bodies as sensor elements with inner boundaries. Each sensor picks up the electric field of beam-excited Langmuir waves.
The simulation results show that the equivalent length for observing the Langmuir waves is almost equal to the sensor's center-to-center distance. They show the features of the wavefront lines of the Langmuir waves around the sensors and explain the distance between two observation points on each sensor element by calculating phase differences of waveforms received by the two monopole sensors. Figure 1 shows the equiphase surfaces of the Langmuir waves. From Figure 1, it is evident that the equiphase surfaces in each element are line-symmetric with respect to the straight line (not shown in the figure) along the x direction through the midpoint of each element. The result is consistent with our results that the equivalent length is almost equal to the sensor's center-to-center distance.

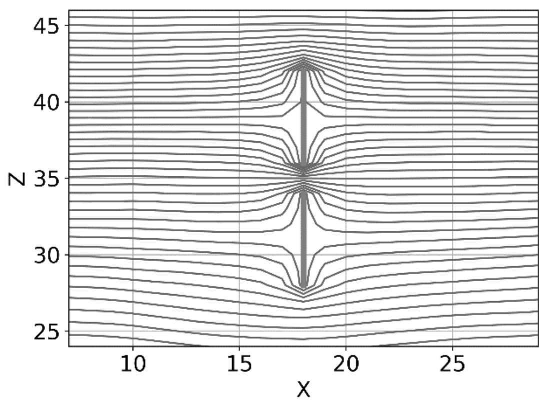

Figure 1. The equiphase surfaces of the Langmuir waves. The two thick gray line segments in the center of the figure along the *z*-axis represent the sensor position.

References

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