How real space considerations can help the study of the evolution of ionospheric irregularities.

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Abstract

Starting with a paper by St-Maurice and Hamza [1] we have pointed out the equivalence of the Fourier and time-space approach in the study of irregularities. In "real world" situations, the Fourier description has shortcomings that force the introduction of complicated nonlinear mode-coupling terms into the calculations. To handle these shortcomings and understand the underlying physics, compromises must necessarily be made concerning the number of modes involved in the coupling and concerning the types of interactions. From a conceptual point of view, these calculation handicaps can be easily overcome with the space-time approach. In that framework, the effect on the evolution of the irregularities of edges at the long end of extended structures are explicitly neglected (these edges are implicitly present in the nonlinear Fourier development anyway). In various papers that have been published or have yet to be submitted, we have explored a few applications of this approach: they include a description of the evolution of modified two-stream waves at high latitudes [1], a simple explanation for the presence of so-called type 2 waves at various *E* region latitudes, a description of the evolution of gradient-drift structures and attendant two-stream waves in the low latitude *E* region [2,3], plus a multiple structuring of *F* region irregularities at high latitudes. A hybrid approach can conceivably also be used to describe the nonlinear evolution of the structures. We are using such an approach to describe the nonlinear evolution of modified two-stream structures at high latitudes. In this work, the space-time approach is being used in two dimensions to describe the rotation of the structures away from the direction of maximum growth. However, this very rotation introduces shears along the magnetic field, thereby evolving large parallel fields that are described most easily in Fourier terms. In this particular example we therefore use time-space in the plane perpendicular to the geomagnetic field and Fourier analysis along the magnetic field direction. This treatment seems to be proving very useful in explaining the nonlinear saturation of the structures at the ion-acoustic speed, the intermediate appearance of so-called type IV structures, the presence of large aspect angles structures of measurable (though smaller) amplitudes at speeds less than the ion-acoustic speed, and electron heating by plasma waves at high latitudes. It even makes sense of some otherwise puzzling evolution detected using CW observations reported in [4, 5].

References

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