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Effect of electrojet irregularities on DC flow

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Plasma density irregularities in the auroral electrojet dissipate energy as evidenced in observations of enhanced electron temperatures by incoherent scatter radar. A theory is presented where extra dissipation and a deviation in the direction of the mean current flow from that of ExB is found to be an effect of the irregularities. The average power input to the turbulent plasma, equal to the product of the externally applied electric field and the mean current, can be equated to the power input with that resulting in a plasma devoid of irregularities but with an increased collision frequency. Similarly one can compute the deviation in direction of the current flow due to the irregularities and compare this with the deviation caused in a plasma without irregularities, but with an increased collision frequency, and from this comparison assign an anomalous dissipation in the plasma caused by the irregularities.

The first order fields and the first order currents are both generated internally in the plasma. They are not the direct results of externally applied processes, and the energy transfer due to these fields and currents is negative, reflecting a loss which turns out to be exactly equal to the external input due the applied field and the mean current. This "lost" transferred energy is then dissipated through the collision losses of all the modes making up the turbulence.

Our study stems from elementary principles and deals with the mean current driven by an external field, including effects of the mean values of second order terms in the perturbed quantities. We do not discuss the elementary processes giving rise to the irregularities in the plasma; only their effect on the mean current flow. The anomalous dissipation is, in this paper, related directly to the angular power spectrum of plasma density fluctuations, but, in contrast to most other works in this field, without discussing the ultimate origin of these fluctuations. Locally the anomalous dissipa-

tion is estimated to be a major source of thermal energy. The conductivities integrated over the E region effectively increase not negligibly when electrojet irregularities are excited.