CALCULATION OF PITCH ANGLE AND ENERGY DIFFUSION COEFFICIENTS WITH THE PADIE CODE WITH APPLICATION TO THE EARTH'S RADIATION BELTS

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We present a new computer code (PADIE) that calculates fully relativistic quasi-linear pitch angle and energy diffusion coefficients for resonant wave-particle interactions in a magnetized plasma. Unlike previous codes, the full electromagnetic dispersion relation is used so that interactions involving any linear wave mode in a predominately cold plasma can be addressed for any ratio of the plasma-frequency to the cyclotron frequency $\omega_{pe}/|\Omega_e|$. The code can be applied to problems in astrophysical, magnetospheric and laboratory plasmas. The code is applied here to the Earth's radiation belts to calculate electron diffusion by whistler mode chorus, electromagnetic ion cyclotron (EMIC), and Z mode waves, and to estimate the timescale for electron loss and acceleration during magnetic storms. We show that the high density approximation is remarkably good for electron diffusion by whistler mode chorus for energies $E \geq 100$ keV, even for $\omega_{pe}/|\Omega_e| \approx 2$, but underestimates diffusion by orders of magnitude at low energies (~ 10 keV). The timescale for electron accleration by whistler mode chorus is calculated from the diffusion rates, and is found to be about 1 day at $L = 4.5$, and compares well with observations. When a realistic angular spread of propagating waves is introduced for EMIC waves, electron diffusion at ~ 0.5 MeV is only slightly reduced compared to the assumption of field aligned propagation, but at ~ 5 MeV electron diffusion at large pitch angles is reduced by a factor of 5, and increased by several orders of magnitude at pitch angles $30^o - 80^o$. Scattering by EMIC waves should contribute to flattening of the distributon function, in addition to that caused by whistler mode waves. The first results for electron diffusion by Z mode waves are presented. They show that, unlike the whistler and EMIC waves, energy diffusion exceeds pitch angle diffusion over broad range of pitch angles less than 45^o. The results suggest that Z mode waves could provide a significant contribution to electron acceleration in the radiation belts during storm times.

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2. H - Waves in Plasma

3. (a)

4. I - Invited Paper

5. No special instructions