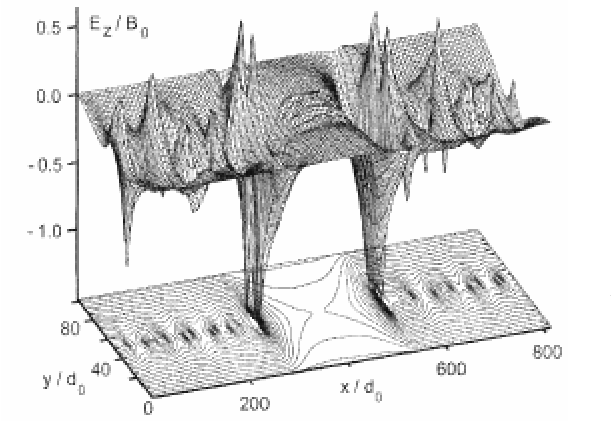
# Synchrotron Radiation in Pair Reconnection

Numerical simulation of relativistic magnetic reconnection in pair plasmas and the resulting particle acceleration is used for the estimation of the synchrotron emissivity from pair plasmas generated for instance in the vicinity of AGNs. It is found that considerable synchrotron radiation can be emitted from those structures in magnetic reconnection activity.

Generation of intense synchrotron emission from reconnection in strong magnetic fields is of great interest in astrophysical problems. It requires the presence of energetic electrons which can have been accelerated in the process of reconnection, and it requires strong enough reconnecting fields or at least strong enough fields at the sites where the fast presumably relativistic particles are injected from the reconnecting accelerator. This is of interest in proton-electron plasmas as long as one restricts oneself to the solar system or magnetized stars, it is of interest as well for pair plasmas when considering AGNs, black hole environments, and the interior of pulsar magnetospheres. We performed PIC simulations on the latter problem as treating proton-electron plasmas is technically very difficult with present computing facilities. The simulation has been fully relativistic in particles and of course in the fields.



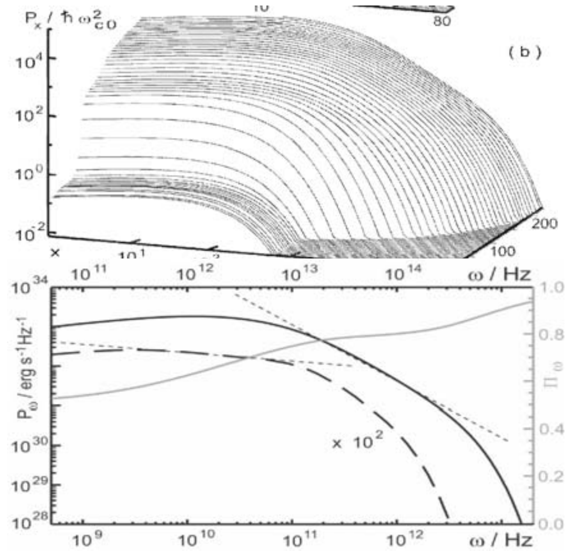




**Figure 1**. *Left*: Accelerating reconnection-electric field. *Right*: Time evolution of synchrotron power emissivity (*top*) and total power spectrum (*bottom*) for the corresponding pair plasma.

Figure 1 shows the locally evolving electric fields in reconnection which accelerate the particles into a power law distribution with high energies. These, in gyrating in the local magnetic fields emit a synchrotron spectrum which is shown integrated over the entire simulation box. Considerable synchrotron power is found being emitted from the box which results from the particle acceleration. This power is generated mainly locally in the reconnection sites and thus is the minimum power available from such processes. When the particle distribution would be collimated into a strong field close to a star or elsewhere the emission would be even higher. Since in application to astrophysical problems the reconnection sites are microscopically small, the size of the particle (in this case pairs) inertial length, one must rescale it to the accessible (observable) spatial volume. We have chosen as such a region the presumable source location of light-jets generated in AGNs. Since the system is absolutely collisionless for the simulation time and synchrotron cooling times exceed it by a factor the order of $10^8$, it is sufficient to estimate the filling factor of the volume to achieve at measured synchrotron emission levels of ~$10^{47}$ ergs/s in certain luminous intraday variable quasars showing extremely hard flat-spectrum radio spectra comparable to our simulation findings of spectral index about -0.2 up to a cut-off frequency of ~100 GHz. Roughly $10^5$ reconnection emission events can be superposed in 1 ks of observation time which guarantees spatial coherence on this scale. Plasma thermalization and synchrotron self-absorption play no role on the individual reconnection scale which lasts only $10^{-7}$ s. Strong polarization at high frequencies > 10 THz is due to the contribution of individual reconnection zones as found in our simulation study.

Jaroschek, C.H., H.Lesch and R.A.Treumann, *Ap.J.* **605**, L9-L12 (2004).

*C. H. Jaroschek and R. A. Treumann*