Final report of the science meeting "Comparison and evaluation of Monte Carlo simulation of bremsstrahlung production in lightning electric fields" at the University of Bergen May 9-11, 2012.

Summary

The meeting was attended by Ragnhild S. Hansen (UoB), Nikolai Østgaard (UoB), Thomas Gjesteland (UoB), Brant Carlson (UoB), Denis Cinar (DTU), Olivier Canrion (DTU).

The meeting was held between May 9 and May 11. The program consisted of presentations by Ragnhild Hansen, Deniz Cinar and Olivier Chanrion, and discussions concerning the modelling of bremsstrahlung.

The main theme of the presentations and discussion was how to include the probability cross sections for production of bremsstrahlung. There are three groups in Europe that are trying to develop codes for simulation of bremsstrahlung production and all groups have chosen different approaches. C. Koehn was not able to attend the meeting but we recieved a draft paper presenting their approach.

Discussion and scientific content

Modelling of the bremsstrahlung process requires four differential cross sections. The total cross section (as a function of the energy of the incomming electron), the single differential (as a function of electron and photon energy), the double differential (a function of electron energy, and photon energy and angle) and the tripple differential (a function of electron energy, photon energy and angle, and angle of outgoing electron).

Experimental values for the total cross section and the single differential cross sections excist for several energies and can be approximated by an interpolation for the remaining energies. The double and tripple differential cross sections can only be found analytically. All analytical expressions for the cross sections are based on simplyfying assumptions. The effect of some of these assumptions is in our context still not clear.

Cinar and Chanrion prsented how they are using the experimental values for the total and single differential, and are using a shape factor to derive the double differential and are neglecting the effect of the tripple differential. Hansen presented how they are using an analytical expression for the tripple differential, which is developed using very few initial assumptions. This is then nummerically integrated to get the other cross sections. The paper by Koehn et. al. explain how they are using a more simplyfied analytical expression for the tripple differential, containing more initial assumptions, and are integrating this analytically to get the remaining cross sections.

During the meeting we dicussed how we expect the cross sections to differ, and wether these differences are expected to affect the result of the model. Depending on the energy of the incomming electron and the outgoing photon, even small differences in the cross section might give big differences in the total model. While for other energies big differences in the cross section might give neglectable differences in the final result.

Outcome of meeting

Few results from the models were avilable on the time of the meeting, but the participants agreed to compare results as soon as these are ready. The outcome of the meeting was an understanding of the advantages and shortcommings of the different approaches. This will be important for the implementation of the models. The modelling of the bremsstrahlung process is very important to be able to compare theories of production of Terrestrial gamma-ray flashes to measurements.

Final Program

Wednesday 9. May

09:00 Presentation by Ragnhild S. Hansen

10:00 Presentation by Deniz Cinar

11:00 Presentation by Olivier Chanrion

12:00 Lunch

13:00-16:00 Discussions

19:00 Dinner

Thursday 10. May

09:00-16:00 Discussions

Friday 11. May

09:00-14:00 Discussions