The influence of small-scale magnetic field on the polar cap X-ray luminosity of old radio pulsars

The influence of small-scale magnetic field on the polar cap heating by reverse position is considered. The reverse position current is calculated in the framework of two models: rapid and gradually screening. In the first model only small scales above upper gap gives the input to reverse position current, so reverse current is equal to $10^{33}-10^{36}$ of primary electron current. In the second model, all scales above lower gap give the input to reverse position current, so reverse current reaches values like $10^{30}-10^{34}$ of primary electron current. Both cases may become the candidates for solving the problem. To calculate the electromagnetic power production rate we take into account only the reverse current production of primary electrons and its absorption in magnetic field. We use the polar cap models with a weak space charge limited electron flow.

It is shown that in the case of small-scale the model of gradually screening predicts too much strong polar cap heating and too large its X-ray luminosity values which exceeds the total observed X-ray luminosity. But in the case of some other models the model of gradually screening seems to be more appropriate than rapid screening model.

Small scale magnetic field

Gradual screening model

The reverse position current for pulsar J0431 - 2740

The polar cap luminosity

Conclusion

References