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Investigation into Transient Processes in Electron Cyclotron Resonance

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Electron cyclotron resonance (ECR) hydrogen ion source has advantages of producing high beam intensity with low emittance and long life, has been wildly used in high energy physics, medical and archaeology, etc. They are among the few efficient devices capable of generating high-intensity H+, H2+, or H3+ ion beams. To better understand the mechanisms underlying the hydrogen plasma discharges, a transient global model was developed at Peking University (PKU). This model is based on the mass and energy conservation equations of electron, H2, H, H+, H2+ and H3+, to describe the variety of number density and energy of these particles at each time-step. Simulation results illustrate the distributions of the key reactions affecting both number density and energy. Additionally, ion fractions are also calculated once the model reaches equilibrium, revealing their dependence on gas pressure and absorbed power. To validate this model, an experiment was carried out with a compact PKU type 2.45 GHz ECR ion source in continuous wave mode. The measured results of ion fractions align closely with those predicted by simulation. This transient global model will provide more precise guidance for design and operation of ECR hydrogen ion sources.

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