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Constraints on millicharged particles from thunderstorms on the Solar system planets

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We investigate the production of millicharged particles (mCPs) by the Schwinger mechanism in thunderstorms in the atmospheres of different planets in the Solar system. We consider a thundercloud as a giant capacitor that can be discharged in two ways: either by lightnings or by mCP production. Taking into account the observation of lightning strikes, we establish the constraints on the charge and mass of mCPs. We examine two types of cloud configurations: a simple arrangement of two clouds, and a more complex layered structure that gives rise to potential wells. In the latter case, we take into account the effects of Bose enhancement for scalar mCPs, and Pauli blocking for fermionic ones. We use the observational data of planetary atmospheres obtained by satellite missions to establish constraints on the charge and mass of mCP particles. The best constraints came from the observation of thunderstorms in Saturn's atmosphere under an assumption of layered cloud structure: we obtain a lower limit on the charge of 10^{-24} for bosonic mCPs. These constraints for bosons are, to the best of our knowledge, the best in the literature.

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