摘要 ：We propose a catastrophic magnetospheric model for magnetar precursors and their successive giant flares. Axisymmetric models of the magnetosphere,
which contain both a helically twisted flux rope and a current sheet, are established based on force-free field configurations. In this model, the helically twisted flux rope would lose its equilibrium and erupt abruptly in response to the slow and quasi-static variations at the ultra-strongly magnetized neutron star's surface. In a previous model without current sheets, only one critical point exists in the flux rope equilibrium curve. New features show up in the equilibrium curves for the flux rope when current sheets appear in the magnetosphere. The causal connection between the precursor and the giant flare, as well as the temporary re-entry of the quiescent state between the precursor and the giant flare, can be naturally explained. Magnetic energy would be released during the catastrophic state transitions. The detailed energetics of the model are also discussed.
The current sheet created by the catastrophic loss of equilibrium of the flux rope provides an ideal place for magnetic reconnection. We point out the importance of magnetic reconnection for further enhancement of the energy release during eruptions.