中性子星にオーロラは光るか?: 中性子星-磁化降着円盤間電磁結合過程の検証

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Can neutron stars have auroras ? : electromagnetic coupling process between neutron star and magnetized accretion disk

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Angular momentum transfer from accretion disk to a star is essential process for spin-up/down of stars. The angular momentum transfer has been well formulated for the accretion disk strongly magnetized by the neutron star [e.g., Ghosh and Lamb, 1978, 1979a, b]. However, the electromagnetic (EM) coupling between the neutron star and accretion disk has not been self-consistently addressed in the previous studies although the magnetic field lines from the star are strongly tied with the accretion disk. In this study, we applied the planet-magnetosphere coupling process established for Jupiter [Hill, 1979] to the neutron star and magnetized accretion disk. Angular momentum distribution is solved based on the torque balance between the neutron star's surface and accretion disk coupled by the magnetic field tensions. We found the EM coupling can transfer significantly larger fraction of the angular momentum from the magnetized accretion disk to the star than the unmagnetized case. The resultant spin-up rate is estimated to ~10^-14 [sec/sec] for the nominal binary system parameters, which is comparable with or larger than the other common spin-down/up processes: e.g., the magnetic dipole radiation spin-down. The Joule heating energy dissipated in the EM coupling is estimated to be up to ~10^36 [erg/sec] for the nominal binary system parameters. The release is comparable to that of gravitation energy directly caused by the matters accreting onto the neutron star. This suggests the EM coupling at the neutron star can accompany the observable radiation as auroras with a similar manner to those at the rotating planetary magnetospheres like Jupiter, Saturn, and other gas giants.