

論文の内容の要旨

Revealing the Origins of Violent Stellar Transients from Fast Radio Bursts and Magnetars

(高速電波バーストとマグネターからの
突発天体現象の起源解明)

氏 名 山崎 翔太郎

The transient sky is a goldmine of enigmatic violent astrophysical phenomena. Fast radio bursts (FRBs) are one of such mysterious transients with millisecond-duration bright radio flashes originating from beyond our galaxy. Most of FRBs have not been observed to repeat and such non-repeating FRBs may be explained by pulsar-like emissions expected from the merger of double neutron stars. In the Chapter 2, by using numerical-relativity simulations of a BNS merger, we examine this scenario with particular focus on the spatial distribution of the matter ejected during the coalescence, which may prohibit the FRB signal to propagate. We show that the formation of ejecta occurs about 1 ms after the rotation speed of the merged neutron star becomes sufficiently high enough to produce an FRB. Furthermore, we propose a new scenario that a super young (1-10 yr) neutron star left after the binary neutron star merger could be the origin of repeating FRBs. In Chapter 3, we highlight one of the key observable quantities of FRBs, the dispersion measure (DM), which is defined as an electron column density from the source to the observer. Thanks to their extragalactic origin, FRBs offer a unique approach to probe the unknown matter distribution inside and outside galaxies. We provide a new model for the hot gas distribution inside our Galaxy, thereby estimating its contribution to the DM of FRBs. Since our model predicts relatively large DM values

over the whole sky, this strong DM signal would be imprinted onto the DM of FRBs, which could be tested by using an increasing sample of nearby FRBs with a small DM.

The second half of this thesis is dedicated to Magnetars, a class of highly magnetized isolated neutron stars, which may be related to FRBs. Magnetars are characterized by their violent flaring/bursting activities in X- to soft gamma-rays with luminosity ranging over ten orders of magnitude. Huge amounts of magnetic energy are released as a hot electron-positron pair plasma (fireball), observed as a flare. We begin Chapter 4 by stressing the possible relationship between magnetar flares and radio transients. We particularly investigate how magnetar flares influence on the coherent radio pulsations and find that radio pulsations would be absorbed by the expanding plasma flow launched by magnetar flares. Since the plasma frequency would decrease with time, the timescale for the radio suppression would be shorter for higher frequencies. Namely, an unambiguous test of our model would be provided by future simultaneous observations of radio-emitting neutron stars at X-ray and at multiple radio frequencies during a period of magnetar flares. Finally, in Chapter 5, we present our recent progress on the spectral formation of magnetar flares in terms of the resonant inverse Compton scattering, which is the most efficient process in the magnetospheres. We develop a toy model taking into account the self-consistent particle velocity distribution under the strong radiation pressure from the flare and perform a 3D Monte Carlo simulation. Our results demonstrate that the original thermal spectrum arising from the optically-thick fireball plasma should be mildly Comptonized, which is in good agreement with the observed burst spectra of magnetar flares observed in 2006 March from SGR 1900+14.