「すざく」衛星のデータを用いた低質量X線連星XB1916-053のdip現象の解明

宇宙航空研究開発機構 宇宙科学研究本部
堂谷研究室　修士課程2年
渡邊　佑馬

Abstract

A close binary system consisting of a weakly magnetized neutron star and a late-type star belongs to a class of X-ray sources, Low Mass X-ray Binary (LMXB). If the X-ray source is moderately bright, it often shows X-ray bursts and dips. Dips are believed to be due to obscuration of the central X-ray source by the outer part of the accretion disk, which has especially large thickness (called "hot spot") due to the impact of the accretion flow from the companion star. However, both the nature of the hot spot and the mechanism of dips are not well understood yet.

In this study, we analyzed the archive data from one of the typical LMXB, XB1916-053, obtained with Suzaku for the total exposure of 124 ksec. Its X-ray luminosity decreased by a factor of 3 during the observations and dips came to appear in the latter half of the 2nd observation. So, we divide the 2nd observation data into three: the first half; dip and non-dip phases in the second half of observations.

We found that the H/He-like Fe absorption lines were always present throughout the observations. While the equivalent width of H-like Fe absorption line was constant at $\sim$42 eV, that of He-like Fe absorption line increased from 21 eV in the first half to 34 eV in the non-dip phase and 65 eV in the dip phase of the 2nd half of the data. This result suggests that the two absorption lines, H-like Fe and He-like Fe, have different origin. For example, the highly ionized plasma responsible for these absorption lines may be located at different site in the binary system. To study this point quantitatively, we analyzed the spectra using a model which simulate absorption by a photo-ionized plasma. This model assumes that the absorbing plasma covers only a fraction of the source. We found that the absorber (hereafter "corona absorber") responsible for the H-like Fe absorption line has an ionization parameter of $\log \xi \sim 4$ and has an extent of 10^8 cm. On the other hand, the absorber (hereafter "dip absorber") responsible for the He-like Fe absorption line have the ionization parameter of $\log \xi \sim 2$ and is located near the outer edge of the accretion disk.

We also investigated the cause of dip appearance in the 2nd half of the observation, which is dimmer than the 1st half by a factor of 3. We analyzed spectra in the first half of observation corresponding to the dip phase. We found that it was difficult to reproduce the energy spectra with the same model used to fit the dip phase spectra by only changing the ionization parameter ξ. So, we tried to vary not only ξ but also the column density of the dip absorber, and found significant improvement in χ^2. This shows that the appearance of dips is not due to the decrease of the ionization parameter only, but the increase of the scale height of the dip absorber contributes significantly. Furthermore, assuming that the dip absorber is localized like the hot spot plasma, we estimated its distance from the neutron star as: $r \sim 6 \times 10^9$ cm. This is consistent to the location of the hot spot, and support the interpretation of the hot spot as the dip absorber. It is not clear why the height of hot spot increased with the decrease of the luminosity, i.e. mass accretion rate. We discussed several possibilities in the text.