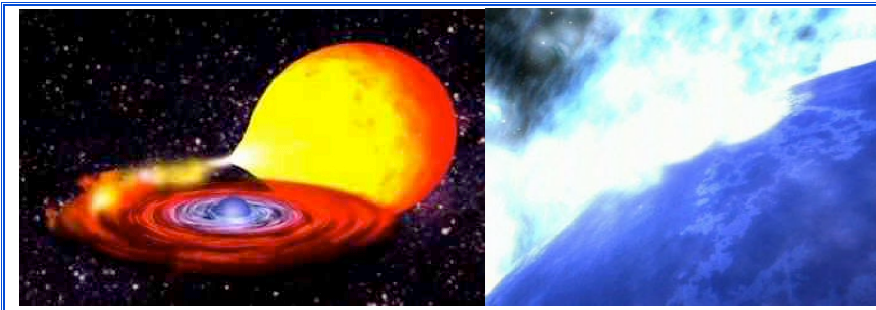
Thermonuclear explosions on accreting neutron stars

J I N A



If a neutron star is part of a semi-detached binary system, hydrogen and helium are slowly transferred from the companion star to the surface of the neutron star. When sufficient amounts of hydrogen and helium has been accreted onto the neutron star, the accumulated matter becomes unstable and burns explosively in a thermonuclear runaway that heats the surface temperature to more than a billion degrees. This causes a burst of X-rays whose specific signature depends on the nuclear reactions on the surface of the neutron star.

Chandra and XMM-Newton regularly observe such X-ray bursts and thus allows us to understand nuclear reactions under conditions that are hard to obtain in terrestrial laboratories. In JINA we have catalogued thousands of the experimental as well as theoretical reaction rates which enter into explosive hydrogen and helium burning. We have also built a self-consistent model of the general relativistic neutron star and the required radiation transport and nuclear reaction networks. This allows us to simulate the X-ray burst and thus study which reactions contribute to the runaway and compare our theoretically simulated bursts to the observed bursts.

Accreting neutron stars along with their theoretical models thus provide a bridge between the fields of observational astronomy carried out by Chandra, XMM-Newton and INTEGRAL and nuclear physics carried out in laboratories at RIA, NSCL, and GSI-FAIR.

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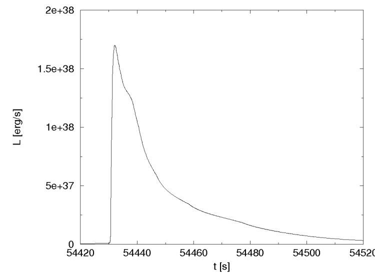
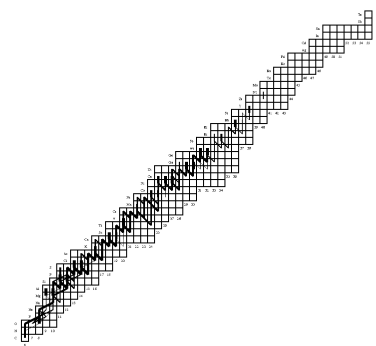


Theoretical X-ray light curve calculated with our fully general relativistic X-ray burst model.



The reaction flow in one of the hundred zones at the peak temperature of the burst.

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