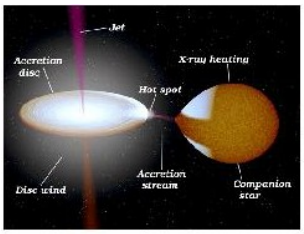
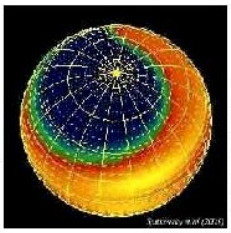
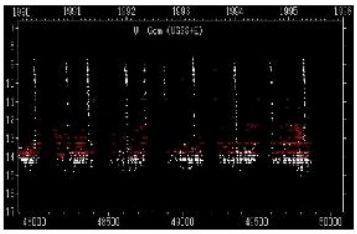
Accretion On To Compact Stars



Accretion in Binary Stars



Nuclear Burning on Neutron Star's Surface



Recurring Outbursts of Luminosity from a Dwarf Nova

Compact stars are very dense stars having masses comparable to our sun. However, white dwarf stars have a size comparable to our earth, while neutron stars have a size comparable to a major city. When these stars occur in a binary system with a normal star as a companion, they draw out the matter from the normal star to form an accretion disk (left panel, above). The matter that lands on the surface of the star can undergo nuclear reactions (middle panel, above) and can also emit a large, episodic luminosity (right panel, above). NASA has made an enormous investment in space-based missions that try to study the nature of accretion in x-ray and ultra-violet wave-bands.

Understanding the physics of accreting matter is important because it serves as a laboratory for studying nuclear reactions. JINA is producing the nuclear reaction rates that make it possible to understand the nuclear processes that take place on the surface of a hot, dense star. To fully understand the accretion processes, we need to understand the details of the gas flows that develop on the surface of the star and the turbulent mixing of the accreted material. To extract the spectrum we need to integrate the nuclear reaction rates into these flows. We have developed some of the most advanced numerical capabilities for simulating accretion processes on the surfaces of compact stars in multiple dimensions.

The simulations have been used to trace the spread of density on the surface of compact stars. The velocity profile in the accretion disk has also been studied because it gives us clues to the state of the matter before it undergoes nuclear ignition and its distribution on the star's surface.

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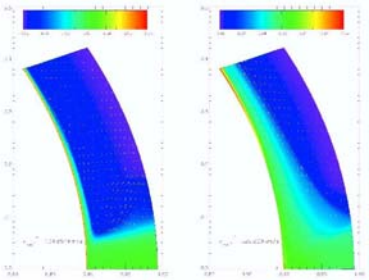
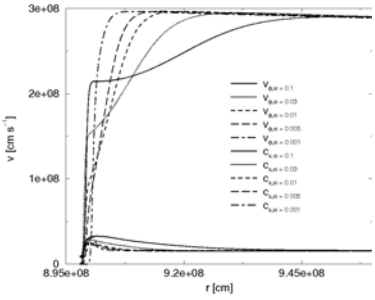
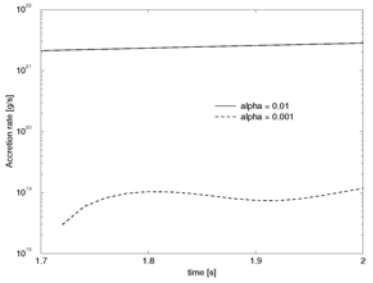


Cross section of the simulated density in an accretion disk that is spreading on to a compact star. Left panel shows formation of an accreted boundary layer during the low state; right panel shows the high state.



Toroidal velocity and sound speed in accretion disks with different levels of turbulence.



Accretion rate on to a white dwarf star for different levels of disk turbulence.

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