'Van Gogh' simulations give new insight into turbulent stars

April 18 2007

Stunning simulations that give a multi-dimensional glimpse into the interior of stars show that material bubbling around the convection zone induces a rich spectrum of internal gravity waves in the stable layers above and below.

The swirling simulations, which are reminiscent of Van Gogh's star paintings, show the interior of a star during the Asymptotic Giant Branch (AGB) phase, the final stage of a low- and intermediate-mass star's life before it becomes a white dwarf. It is during this phase that many of the heavier elements, such as carbon and sodium, are created inside the stars.

The core of the star is surrounded by shells of helium and hydrogen, in which nuclear fusion periodically switches off and on in a process called Helium-Shell Flashes, triggering increased bursts of mixing and heating. The models focus on the turbulent convection zone in the helium shell and show how it interacts with the stable, stratified layers above and below.

Dr Falk Herwig said, "Until recently we've only had one-dimensional models of the interior. That's very different from being able to work out in detail and 2 or 3 dimensions what's going on deep inside and seeing how the different layers interact. The three-dimensional simulation is so complicated that we have been using as much computing time as some of the large cosmological simulations. This is the first time that we've been able to see and actually measure the internal gravity waves that are caused by the convective motions in the unstable layer."

The simulations show that there is minimal penetration of material into adjoining layers from the convection zone but gravitational mode oscillations with a dominating horizontal velocity component, induced at the convective boundaries do cause some of mixing across layers.

Helium-shell flash convection is dominated by large convective cells that are centered in the lower half of the convection zone. The animations show entropy or temperature fluctuations which start off as small bumps at the bottom of the convection zone and expand upwards, developing mushroom-like instabilities that merge into large-scale features. The stable regions above and below are filled with horizontal waves, which are induced almost as soon as the convection plumes start to grow. This means that the gravity waves are not created by the plumes actually hitting the boundaries, but are induced by the build-up of pressure above the plumes.

Source: RAS

Citation: 'Van Gogh' simulations give new insight into turbulent stars (2007, April 18) retrieved 20 April 2024 from https://phys.org/news/2007-04-van-gogh-simulations-insight-turbulent.html