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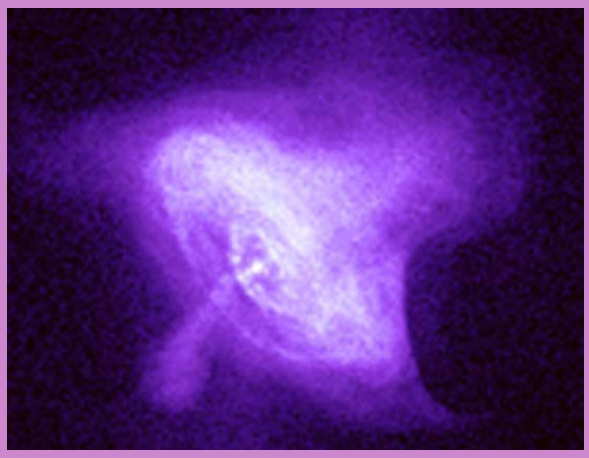
Pulsars - Cosmic Ballerinas

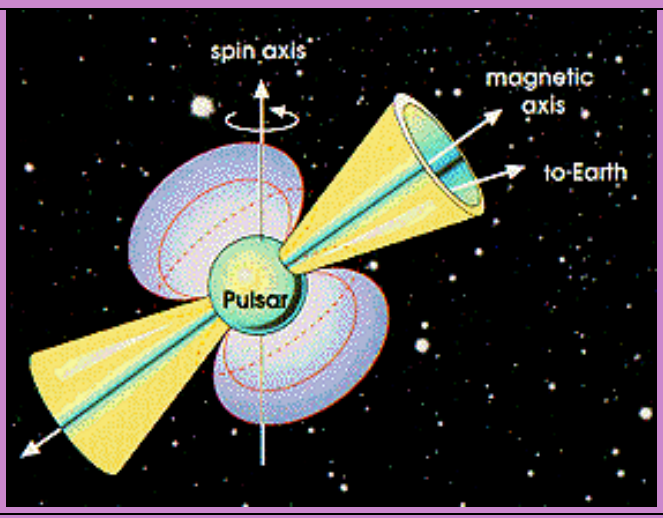
Pulsar are cosmic 'lighthouses' - found in brilliantly lit nebulae, and spinning 30 times a second, like real tops, says S.Ananthanarayanan. How do they get so bright and why do they spin?



Stars are formed when vast expanses of interstellar dust draw together due to gravity. As these particles get closer, they heat up and get so hot that they turn into a 'nuclear fire', a giant hydrogen bomb, rather like our own sun.

But if the star gets too hot, then it expands again, till it cools, and then it contracts, expands, and so on. Till it really caves in to crush the particles together so hard that they go off in a colossal explosion, as a 'supernova'.

Now, when this supernova caves in, there is no nuclear fuel to slow down the collapse. Unchecked, the pressure gets so great that protons and electrons merge into neutrons, neutral particles that can get really close together, to create the densest form of matter imaginable.



The intense energy that this mass gives off illuminates the surrounding cloud, as a 'nebula' that lasts for centuries after the supernova explosion.

But the remarkable thing is that this energy comes to us in 'bursts' or 'pulses', as if the neutron core were spinning rapidly!

Ballerinas

Ballerinas, ice skaters, acrobats, who spin round on their toes, start by spinning with their arms outstretched. But by suddenly drawing their arms in, they begin to spin much faster!

The principle is the conservation of angular momentum. To set anything spinning, a top, a ballerina or a planet in space, some work has to be done. This energy is stored in the spinning body in its 'spinning momentum', just like the energy used in pushing a car is stored in the momentum of the car in motion. Usually, the car will keep rolling and will prove that it has all this energy when it knocks something down.

In the case of a spinning body, like a flywheel, the energy is stored more in the parts more distant from the axis of spin, than in the parts right next to the centre. This makes sense, because the parts at a distance from the axis are moving faster! Just think of how they make a flywheel - they put most of the weight along the rim, so it could store the most energy. Now in a spinning body, if the distant parts are suddenly drawn nearer the axis - where is the energy to go? Well, because the spinning masses are now nearer the axis, the spin just becomes faster!	

This is what is happening when the ballerina draws her arms inward!

The neutron ballet

Much the same happens with the neutron star. The thousands of light years-wide cloud of gas that a star sets out as is not at rest. It is drifting and turning around too. This turning motion has to be conserved as the star ‘waxes and wanes’, to end up at last as a disk just 10 kms in diameter!

Well, all that spinning momentum gets expressed as a spin that a real ballerina could scarcely imagine!
