E T1 The magnetic fields of A-stars and white dwarfs explained

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Since the discovery of magnetic stars over half a century ago, there have been two competing ideas to explain their magnetism: one theory proposes that the magnetic field is generated by a convective dynamo process operating in the core of the star. The other, the so-called fossil-field theory, claims that the field is simply left over from the formation of the star, having been present in the gas cloud out of which the star condensed. There is circumstantial evidence in favour of the fossil-field theory, but the main problem has been the lack of a known magnetic field configuration which is able to survive for a sufficiently long time. All configurations considered so far (by analytic means) are unstable and would decay in a matter of years, (i.e. very quickly compared to the lifetime of a star). There has to be a stable configuration, and the field has to have a way to find it. This special configuration has now been found, using numerical simulations to follow the evolution of an arbitrary initial field as it relaxes into a stable state.

The stable field has the shape of a twisted torus, not unlike the fields used in fusion reactors. It is roughly axisymmetric and the field on the surface of the star is approximately dipolar, but not exactly, in agreement with the observations. Its shape and existence appears to be closely linked to a global property called magnetic helicity.

With these results there is now a reliable basis for the theory of the magnetic fields in A-stars, white dwarfs and neutron stars.