

Supernova driven turbulence in the interstellar medium

Galaxies

Galaxies are highly dynamic environments containing extremes of temperature, mass and shock waves travelling at many kilometres per second. Spiral galaxies rotate at speeds of about 200 km/s and form a flattened disc shape.

The earth orbits the Galaxy every 200 million years and is about 2/3rds of the distance from the centre. The spiral arms are an effect of the twisting and shearing of galactic material as the stars near the centre orbit more often than the most distant stars.

In the background is an edge on view (Sombrero galaxy) and inset right a face on view (The Whirlpool Galaxy (M51)).

Supernovae will appear as tiny specks of light within the vast scale of a galaxy. The images below of SN remnants (N63A and Wolf-Rayet star WR124) are represented as blow-ups from the disc to give some idea of scale



The nearest stars to the Sun, Proxima Centauri and the brighter Alpha Centauri, are about one parsec (3.086×10^{13} km) away.

It takes ten years for light from one of these neighbours to reach us.

Supernovae

On a smaller scale the motion of galaxies is very turbulent. Violent explosions from young hot stars blast material four times the mass of the Sun at speeds of about 30,000 km/s (1/10th speed of light) into space.

Typically a supernova (SN) instantly explodes the equivalent energy of 10^{30} modern nuclear war heads (that's thirty noughts on the end). These events occur at roughly the rate of five times per century within our Galaxy.

Interstellar medium

The space between the stars is not empty. The interstellar medium (ISM) is filled with a tenuous gas. Its mean density is 1 atom/cm³. The air at sea level by comparison has 10^{21} atoms/cm³ (twenty-one noughts on the end). The interstellar atmosphere includes thicker clouds with temperatures of a few tens of Kelvin(K) (-250°C) and hot diffuse bubbles of tens of millions K.

This very turbulent and inhomogeneous material is threaded by intense magnetic fields capable of generating powerful electric storms. It is unclear how the magnetic fields can remain so strong. It is possible that the chaotic storms driven by supernovae may be maintaining the magnetic field.



A typical shock wave from a supernova explosion extends in all directions to about 70-150 parsecs (a useful astronomical length).

Our Galaxy has a radius of about 16 kilo parsecs. The Sun is estimated to be 8 kilo parsecs from the centre.