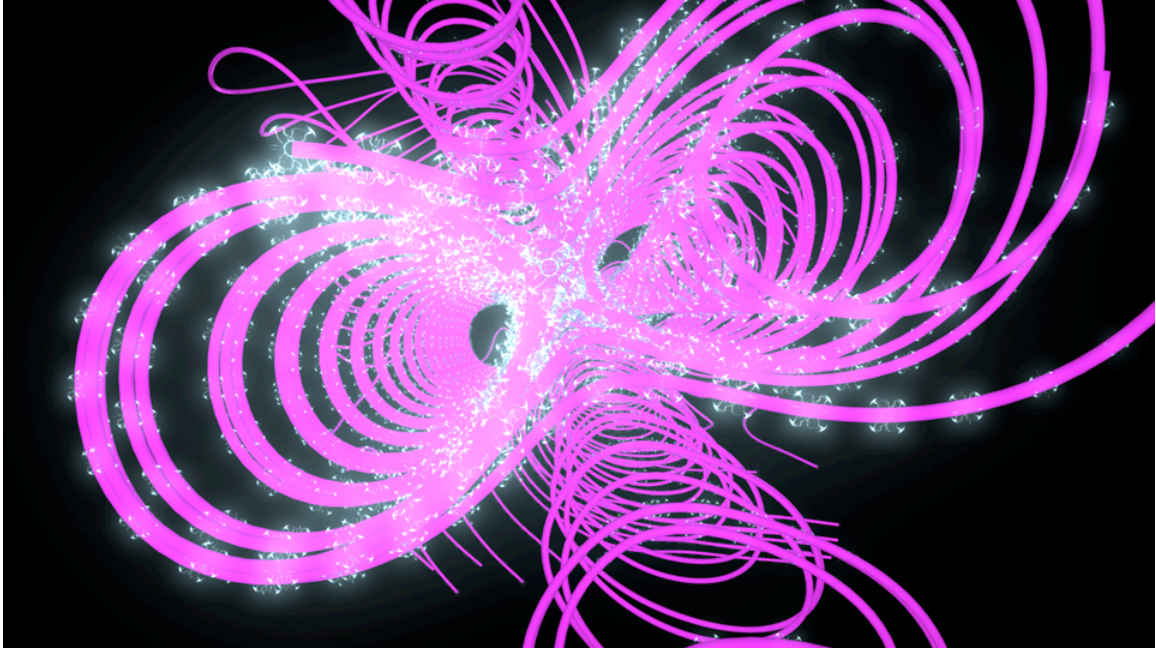


The Many Faces of the Shear Alfvén Wave

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Plasmas support a large variety of waves, some are familiar such as light and sound but a great many exist nowhere else. One of the fundamental waves in a magnetized plasma is the shear Alfvén wave. (Named after a Nobel prize winning scientist who predicted their existence.) Plasmas are in general, phenomenally good conductors of electricity and electrical currents with frequencies less than the inverse of the time it takes an ion to make one rotation about the magnetic field are, in fact, the currents of shear waves. It has become apparent that Alfvén waves are important in a wide variety of physical environments. They play a central role in the stability of magnetic confinement devices, give rise to aurora formation in planets, and are thought to contribute to heating and ion acceleration in the solar corona. Shear waves of finite transverse scale have electric fields parallel to the local background magnetic field, which is key to understanding current systems, and they can also cause particle acceleration over considerable distances in interstellar space. One may also consider magnetic flux ropes, twisted bundles of magnetic fields that have helical current as low frequency shear waves. Shear waves can become nonlinear and in astrophysical environments this is proposed to result in turbulent cascades and the generation of structures. It is possible that Alfvén waves power the aurora borealis they have been directly observed in the solar wind, the auroral ionosphere and magnetotail, in the sun's corona, and in fusion devices. Shear waves of various forms have been a topic of experimental research for more than fifteen years in the Large Plasma Device (LAPD) at UCLA. The waves were first studied in several regimes it was discovered they could be launched by different types of antennas or exploding laser produced plasmas, and radiation from fast electrons produce by intense microwaves. The creation process gives rise to exotic spatial patterns, such as the one shown below, nevertheless they are all Shear Alfvén waves. Careful studies have mapped the motion the currents , the ion motion, and propagation in inhomogeneous magnetic fields and density gradients. Heating of the plasma electrons and ions has also been observed. Magnetic flux ropes as well as temperature filaments also exhibit shear wave phenomena. Three-dimensional data, such as the magnetic field of one of these waves shown below will be presented along with relevant theory. Part of the presentation will be in 3D!



Three-dimensional magnetic field (due to four currents threading the center of each helix) of a shear Alfvén wave. This is a representation of data acquired at an instant of time throughout the volume of a large (60 cm dia ,18m long) plasma in the LAPD device at UCLA. The currents and the field topology change in fractions of a millionth of a second. The sparkles are proportional to the electric field in the plasma induced by the wave.