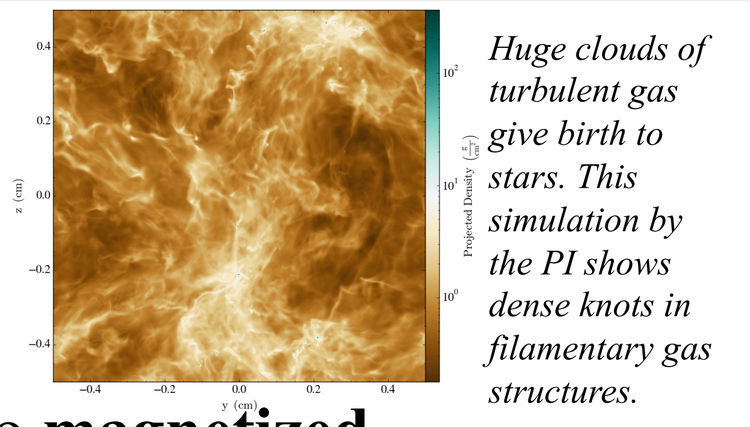
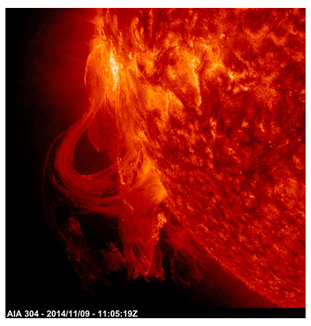
David C. Collins Presents

# The Chaos from Outer Space vs The Magnetic Field

Essentially every astrophysical object is made of turbulent gas. Being turbulent, it is **chaotic**, which makes it nearly impossible to predict all of its behavior. Our group relies on supercomputers and advanced software for understanding.




*Huge clouds of turbulent gas give birth to stars. This simulation by the PI shows dense knots in filamentary gas structures.*



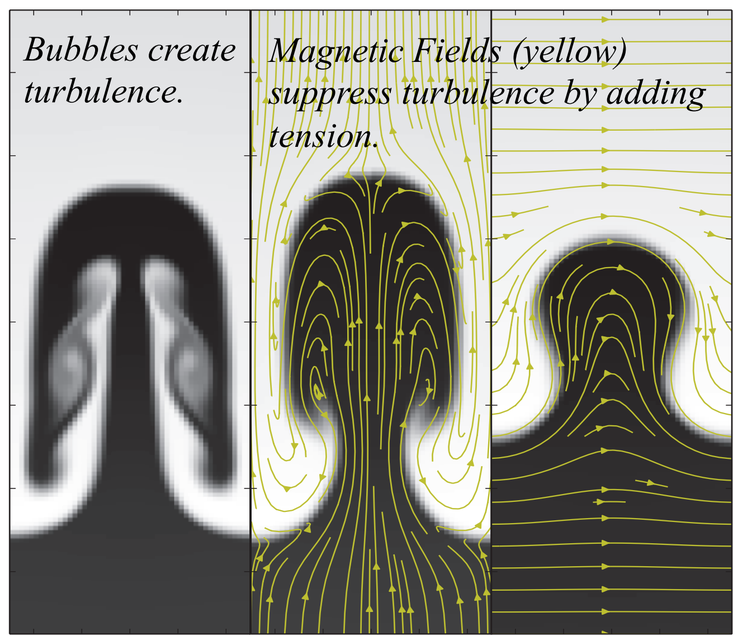

*This is the sun, as seen by the satellite SDO. This loop is hot gas confined to follow the magnetic field.*

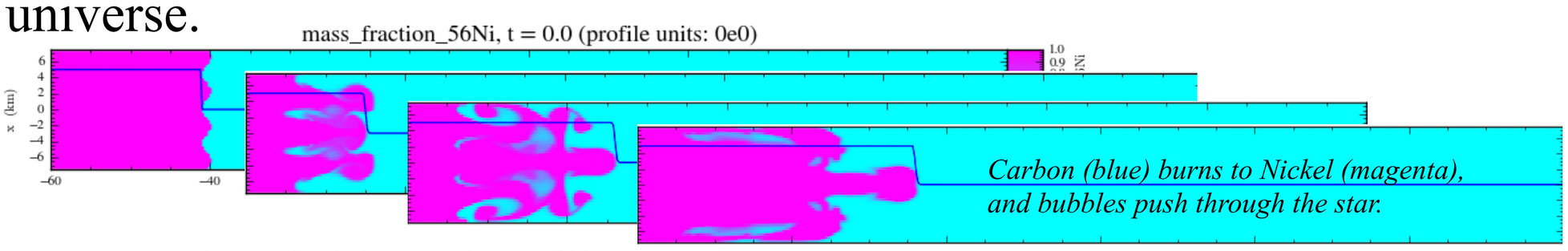
In addition to being turbulent, this gas is also **magnetized**. Magnetic fields provide tension and pressure to the gas, much like rebar in concrete. Sometimes magnetic fields help *tame the chaos;* sometimes the magnetic fields can and *drive further turbulent chaos*.

The FYAP program helped me and my collaborators work on several projects. These projects use simulations to explore the interplay between turbulence and magnetic fields.

## *Magnetic Fields Tame Chaos in Supernovae*

Supernovae are the explosive nuclear burning at the end of a stars life. This burning creates bubbles that cause turbulence. Magnetic fields, like rebar, can stop the bubbles from becoming more chaotic. Graduate student Boyan Hristov has extended our software to include nuclear burning, and is undergoing a study of how magnetic fields affect the death of stars. This allows us to better use these supernovae to probe the distant universe.

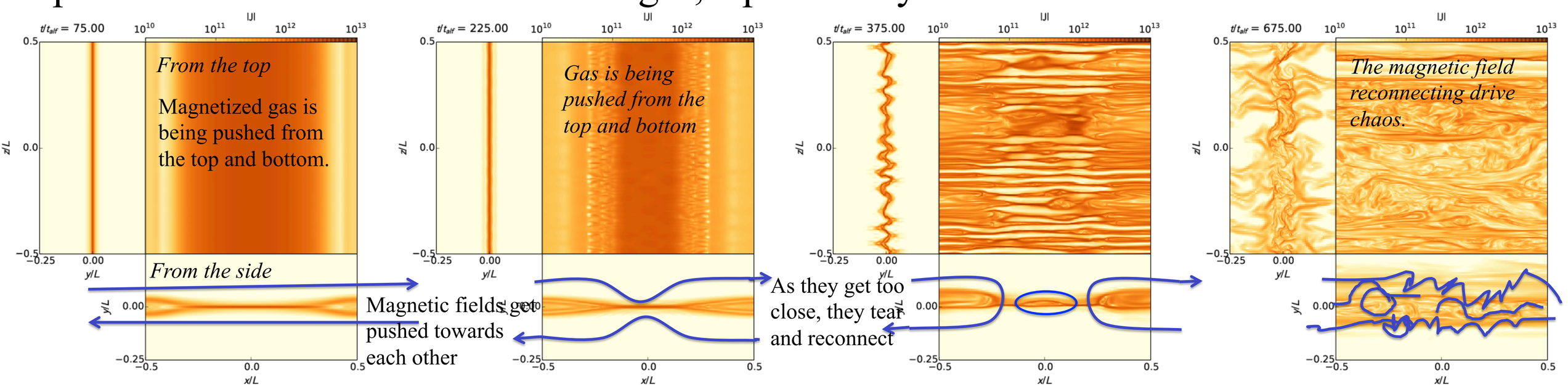



*Above: A simple simulation showing that magnetic fields can suppress mixing in bubbles. Left: A calculation showing nuclear burning driving bubbles*

## *Magnetic Fields Drive Chaos*

When magnetic fields get compressed or sheared, they can tear and *reconnect.* Like snapping rubber bands, this releases energy from the field into the gas. This process is at work in the sun, driving huge mass ejections; it drives the Aurora by exciting particles; it may drive the formation of stars. Collaborators and I have shown that this reconnection process can drive turbulence in the gas, a previously unknown result.

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