

Who Am I?



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Professor of Physics and Electrical and
Computer Engineering
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How Did I Get Here?

High School

Ramsey High School -1969
Ramsey, NJ

College

BS (Electrical Engineering) 1973
MS/PhD (Plasma Physics) 1976

Career

Post Doc Naval Research Lab 1 year
Research Scientist (MIT 3 years)
Joined University of Maryland in 1980

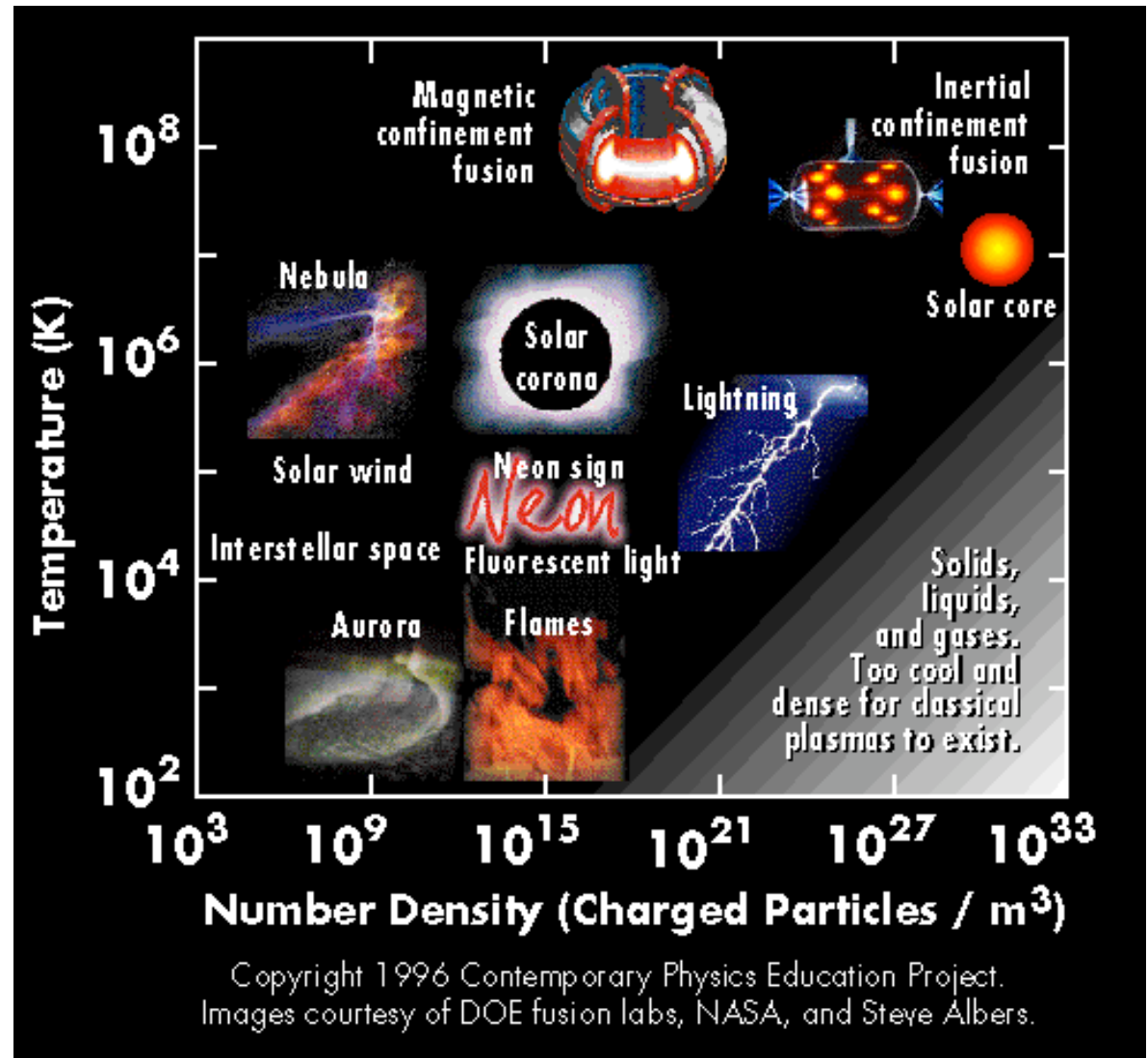
1969-2011 41/42 years at a University

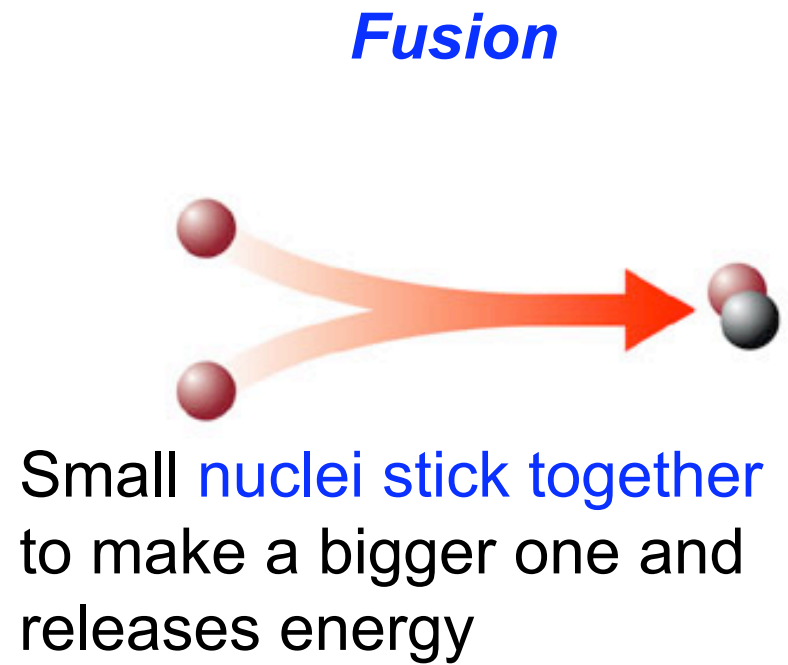
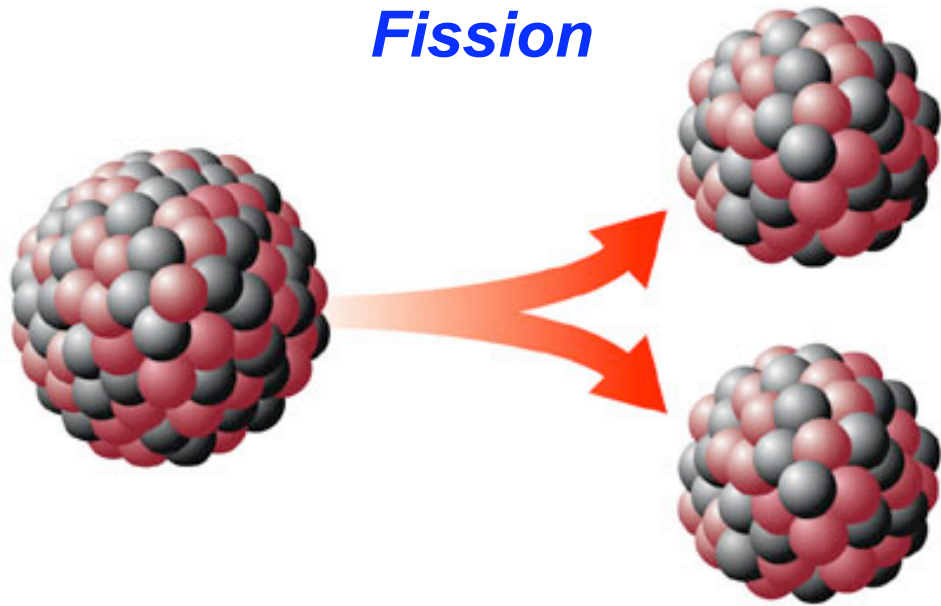
Plasma Physics

Plasma is the fourth state of matter (solid, liquid, gas, plasma)

Most of the visible universe is plasma

<http://FusEdWeb.pppl.gov/>





- Fusion powers all the stars, including the Sun.
- The fuel is hydrogen, but it has to be heated to millions of degrees to ignite the burn
- Power plants based on fusion could supply all our electrical needs. They could also be used to generate hydrogen for fuel cell cars, thus reducing consumption of oil.



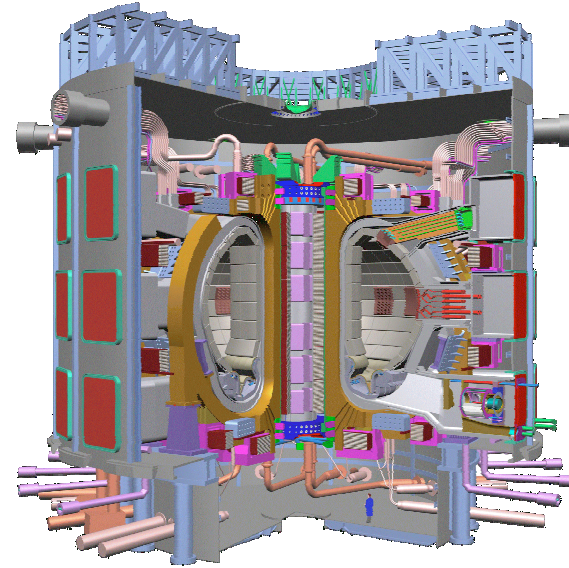
Why Fusion?

- Fuel is inexhaustible and available to all (from water)
- There is no CO₂ emission
- There is no danger of a runaway or a meltdown – turn it off like a gas burner
- Waste is low level and has to be monitored only for 50-100 years (Yucca Mountain is for ~10,000 years)
- Low risk of nuclear materials proliferation - No uranium or plutonium

State of the Art

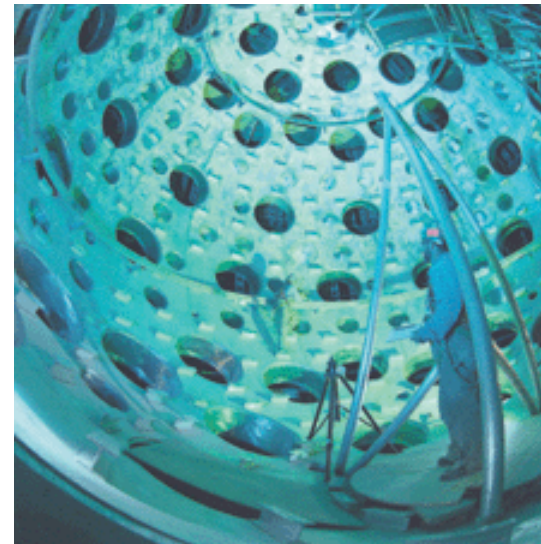
Magnetic Confinement: ITER

US-EU-Russia-Japan-India Collaboration
Will be built in Cadarache France
Completion 2016??
<http://www.iter.org/>

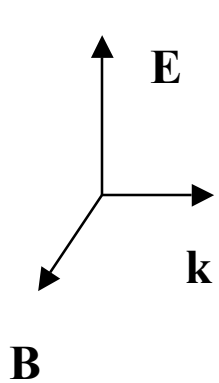


Inertial Confinement: NIF

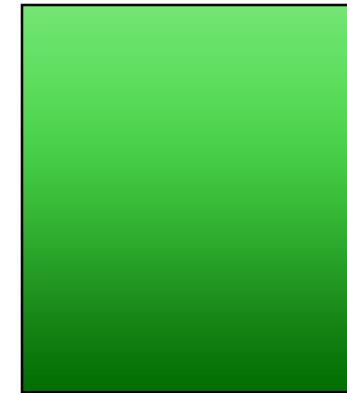
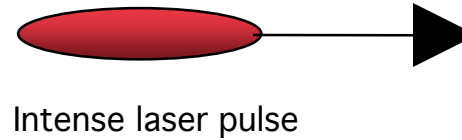
Lawrence Livermore Lab
Under construction
Completion expected in 2008
<http://www.llnl.gov/nif/>
Similar program in France



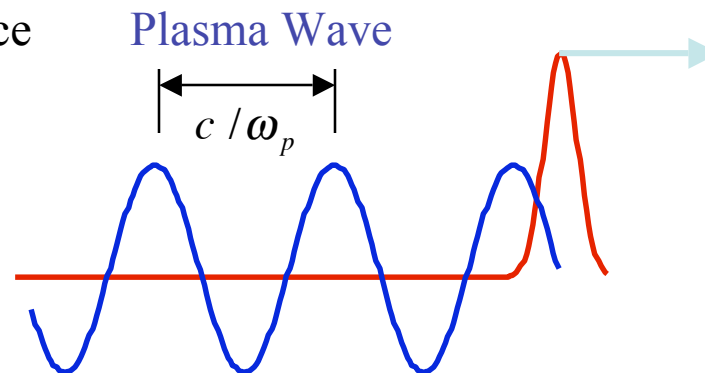
Particle Acceleration Using Plasmas



Direct acceleration
limited to laser period



Plasma wave driven by force
of laser pulse



Laser Pulse

Duration of pulse matched
to plasma period

Speed of wave = group
velocity of laser pulse

$I=10^{18} \text{ W/cm}^2, L= 10\text{cm} \quad \Delta E \sim 1 \text{ GeV}$

How Does it Really Work?

Analogy:

Laser Pulse	↔	Boat
Plasma	↔	Lake
Plasma Wave	↔	Surface Wave
Electrons	↔	Surfer



Relativity: Small change in velocity → Large change in energy

Injection ↔ Tow rope