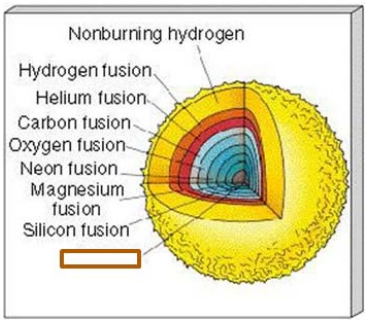
Introduction to Nuclear Fusion (409.308A)

Midterm Examination

1 November, 2018

1. Answer the following questions.

(1) (5 points) The layers of fusion in a star is shown below. What does place in the very core of the star? Fill ☐.



(2) (5 points) The Coulomb potential barrier of D-T fusion is about 0.4 MeV but the energy of deuteron and triton ions are about 0.02 MeV in a fusion reactor. Discuss how the fusion reaction is possible in this fusion reactor.

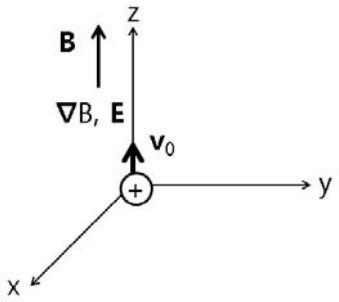
(3) (5 points) How long is the sun's life time? Why is it so long?

(4) (5 points) What is the thermonuclear fusion?

2. (10 points) Derive the fusion reaction rate density.

3. (10 points) Describe the ignition condition of a fusion reactor.

4. (1) (10 points) Draw and explain the trajectory of the electron with the initial velocity $\mathbf{v}_0$ when electric fields, magnetic fields and ∇B are applied in z-direction as shown in the figure below.



(2) (10 points) Draw the trajectory of an ion trapped in the magnetic field of earth.

(3) (10 points) What is the main instability observed in mirror devices?
How to mitigate or stabilise it?

5. (10 points) Why is the plasma current needed in the toroidal direction in a tokamak?

6. (20 points) Evaluate the statements: O if correct, X otherwise.
(1) Seven parties, China, EU, India, Japan, Korea, Russia, USA, are participating in the ITER project to demonstrate the scientific feasibility of fusion power of Q >

(2) The shock ignition is a type of the direct inertial fusion energy using a cone. ( )

(3) TFTR is the tokamak device which achieved Q ~ 0.64 in operation with deuterium and tritium. ( )

(4) Plasma beta is the ratio of the magnetic tension to the plasma pressure as . $\beta = \frac{p}{B^2/2\mu_0}$. ( )

"Wisdom is supreme; therefore get wisdom. Though it cost all you have, get understanding." (Proverbs 4:7)