

Magnetic Field and Current Profile Diagnostics for the VINETA II (V.II) Magnetic Reconnection Experiment

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Magnetic reconnection is the topological rearrangement of magnetic fields through the breaking and reconnection of magnetic field lines. It plays an important role in many space plasmas, such as solar flares, as well as in some laboratory processes.

A review of the planned upgrade of the linearly magnetized plasma device VINETA is given. The setup of VINETA has been modified by adding a new module, whose larger dimensions will allow for the study of the plasma dynamics of driven magnetic reconnection. Furthermore, diagnostic tools for magnetic field and current measurements are presented. An array of induction coils will be used for determening the spatio-temporal evolution of the magnetic field. Current profile measurements will be done using a Rogowski coil.



Reconnection in Space





http://upload.wikimedia.org/wikipedia/commons/a/aa/Polarlicht_2.jpg]





[http://sprg.ssl.berkeley.edu]

Reconnectina Magnetic Field Line

> New Reconnected agnetic Field Lines

> > _arge Corona

Inflowing

Magnetic Field

Hot Flare

[http://www.nasa.gov/vision/universe/solarsystem/solar_cycle_graphics_prt.htm]

Induction Equation: $\frac{\partial B}{\partial t} = \nabla \times (\boldsymbol{v} \times \boldsymbol{B}) + \frac{\eta}{\mu_0} \nabla^2 \boldsymbol{B}$

Collisional vs Collisionless Reconnection





Asumptions:

- Steady state
- The plasma is an incompressible fluid
- Mass is conserved
- Uniform pressure
- Field lines and plasma expelled at velocity V_{out}=V_a

Problems:

- Observed reconnection rate much faster than predicted
- Model does not explain collisionless reconnection





0.2∧^ч∧.1 V_R/V_A 0.0 0.0 0.2 0.0 0.2 0.1 0.1 1/√S $1/\sqrt{S_{eff}}$

Comparison of Sweet-Parker Model with Experiment

Measurement of Electromagnetic Fluctuations During Fast Reconection





[M. Yamada, "Review of Controlled Laboratory Experiments on Physics of Magnetic Reconnection," Journal of Geophysical Research 104 14,529 (1999)]



Experiment



Working Gas	Argon	Guide Field	B _z < 0.1 T	
Pressure	р= 10 ⁻³ Ра	Electron Temperature	T _e =6eV	
Density	n=10 ¹⁶ m ⁻³	Lundquist Number	S= (1.2-4.9)*10 ³	

Reconnection Drive



- Current produced by resonant LC circuit
- Parallel conductors produce in-plane magnetic field





Driving Current	I _D =3kA		
Drive Time	τ _D =10μs		

Time [us]

Time [us]

10

Current MonitorRogowski Coil

Magne	tic Field Diagnostics			Current Diagno	ostics	Induced Voltage of Rogowski Coil
B-probe array:Inductive coils		Sensitivity of Single Probe	Capacitive pickup	A	Rogowski Coil for of Current	r Determination t Profile ↓ 0.4 ↓ 0.4 ↓ 0.2 ↓ 0.4 ↓ 0.4

