Plasma response to sustainment with imposed-dynamo current drive in HIT-SI and HIT-SI3

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Abstract Text:
The helicity-injected torus with steady inductance (HIT-SI) is a one-meter diameter experiment which forms and sustains a spheromak using inductive helicity injectors. Each injector is a semi-toroidal duct in which loop voltage and magnetic flux are oscillated in phase, injecting helicity. On the original HIT-SI device, two injectors were positioned on opposite sides of the spheromak and oscillated 90 degrees out of phase yielding steady helicity injection. The injected mode spectrum was predominantly n=1 due to the injector geometry. Once formed, the spheromak is sustained with imposed-dynamo current drive (IDCD). The injector-linking plasma is driven with $? = \gamma_0j/B$ greater than that of the spheromak, resulting in sheared electron flow at the separatrix. The oscillating magnetic flux from the injectors imposes n=1 perturbations on the spheromak. The perturbations are distorted by the sheared electron flow resulting in a viscous-like force on the electron fluid and current drive across flux surfaces. Sustainment of stable, high-beta spheromaks has been demonstrated previously in HIT-SI. New evidence from ion Doppler spectroscopy (IDS) measurements shows coherent plasma motion at the injector frequency, indicating that the spheromak moves as a rigid object in response to the oscillating injector currents. Coherent, rigid motion indicates that the spheromak is stable and a lack of plasma-generated n=1 energy indicates that the maximum q is maintained below 1 during sustainment.

Initial results from the HIT-SI3 device are also presented. Three inductive helicity injectors are mounted on one side of the spheromak flux conserver. Steady helicity injection is achieved by oscillating the injectors 60 or 120 degrees out of phase. Varying the relative injector phasing changes the injected mode spectrum which includes n = 2, 3, and higher modes. Spheromaks have been sustained with toroidal current three times greater than the quadrature sum of injector currents.

Comments: