Alfvén range instabilities in H-1: interpretation, mode structure, and relation to rational surfaces.

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The H-1 flexible heliac (R/<a>=1/0.2m,[1]) is a 3 period stellarator which exhibits a range of shear from low negative values ("tokamak like") to moderate positive shear. Configuration scans in the range $1.1 < \iota_0 < 1.5$ have shown a detailed rotational transform dependence of plasma density and fluctuation spectra. Fluctuations are observed in the range 1-150kHz, on two arrays of magnetic probes and on a 2mm density interferometer. Detailed configuration studies have been performed on hydrogen/helium plasma at 0.5T ($<n_e>\sim 1\times 10^{18}$, $1.1 < \iota < 1.5$). Datamining[2] of the ~1GB data set has revealed several clusters of phenomena, a number of which exhibit Alfvénic frequency scaling with both ι and n_e, within a constant factor in frequency. Mode numbers are derived from poloidal and toroidal phase differences, and are typically n/m=4/3, 5/4 and 7/5, and consistent with ι. Observed frequencies are proportional to $\omega/V_A = k_{\|} = (m/R_0)(\iota - n/m)$, and show clear "V" structures near rational surfaces ($\iota \sim n/m$). In addition to their intrinsic interest, in a low shear device such as H-1, these structures can provide accurate locations of resonant surfaces under plasma conditions, which are found to agree very well with recent magnetic field line mapping[3] at high magnetic field.

The radial structure of these modes has been unravelled (figure 1) from synchronously-detected line integral density scans across the plasma. This is compared with eigenmode structures computed by the CAS3D code. A significant fraction of clearly non-Alfvénic fluctuations indicate that other instabilities are present. Possible interpretations as interchange, sound or drift modes are discussed. These and other recent observations of Alfvén activity in various low and high temperature plasma, thermal and non-thermal suggests these phenomena may be more ubiquitous --and thus fundamental to toroidal confinement--- than previously thought.

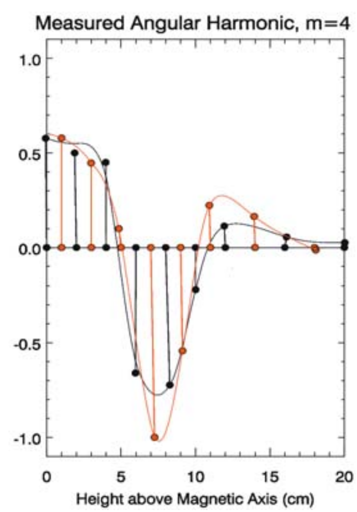

Fig. 1: Radial structure of oscillations in n_e (projections)

[1] Hamberger S.M., Blackwell B.D., Sharp L.E. et al., *Fusion Technol*. **17**, 1990, p 123.
[2] B. D. Blackwell**,** D.G. Pretty et al., 21st IAEA Fus. Energy Conf., Chengdu, China, 2006
[3] S.T.A Kumar, B.D. Blackwell and J.H. Harris, Rev. Sci. Ins, **78** 013501-8 (2007)