MARFE stability analysis of an ELMy H-mode Discharge in the National Spherical Torus Experiment*

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We present the results of a comparison of MARFE (Multifaceted Asymmetric Radiation From the Edge) theory[1,2] with experiment in the National Spherical Torus Experiment (NSTX). This experiment was conducted with plasma current I_p = 0.9 MA and on-axis toroidal field B_t = 0.45 T, in a double null discharge shape with elongation $\kappa \sim 2.4$, triangularity $\delta \sim 0.7$, and the ion grad-B drift toward the X-point. Using a fast-framing camera, MARFEs are observed to move and to interact with edge-localized modes (ELMs) during the ELM cycle[3]. Thomson scattering (TS) measurements occur at 60 Hz, charge exchange recombination spectroscopy (CHERS) measurements occur at 100 Hz and the analysis is restricted to times where $| t_{TS} - t_{CHERS} | < 1.5$ ms , since the time scale for MARFE growth is less than 1 ms. A MARFE theory[1,2], which incorporates non-equilibrium radiation effects of neutrals in a uniform edge but neglects perpendicular heat conduction and atomic cooling, was applied to NSTX data. Timing restrictions, uncertainty in the location of the separatrix location and lack of neutral data constrained the analysis. A parameter scan of the neutral fraction revealed the MARFE density limit predicted by theory[1,2] to be consistently higher relative to the measured edge density for times when no MARFE is present than at times when a MARFE exists. In order to make a more definitive statement regarding the validity of the theory[1,2], the temporal and spatial resolution of the measurements need to be improved and/or supplemented by computer simulation.

The movements of MARFEs in the same H-mode discharge are interpreted to result from the combined effects of the E × B and diamagnetic drifts. MARFE velocities, inferred from observations by a fast-framing camera[3], imply that the radial electric field on the high field side is ~ -1 kV/m at 377 and 661 ms.

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1. M. A. Mahdavi, et al., in *Proc. 24th European Conf. Controlled Fusion and Plasma Physics*, Berchtesgaden, Germany, 1997, vol. 21A, p. 1113, European Physical Society (1997).
2. R. Maingi and M. A. Mahdavi, 2005 Fusion Sci. Technol., **48**, 1117.
3. R. J. Maqueda, 2007 J. Nucl. Mater. **363-365**, 1000.