Lithium Polarization Spectroscopy: Making Precision Plasma Current Measurements in the DIII-D National Fusion Facility*

D.M. Thomas

General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA

Abstract. Due to several favorable atomic properties (including a simple spectral structure, the existence of a visible resonance line, large excitation cross section, and ease of beam formation), beams of atomic lithium have been used for many years to diagnose various plasma parameters. Using techniques of active (beam-based) spectroscopy, lithium beams can provide localized measurements of plasma density, ion temperature and impurity concentration, plasma fluctuations, and intrinsic magnetic fields. In this paper we present recent results on polarization spectroscopy from the LIBEAM diagnostic, a 30 keV, multi-mA lithium beam system deployed on the DIII-D National Fusion Facility tokamak. In particular, by utilizing the Zeeman splitting and known polarization characteristics of the collisionally excited 670.8 nm Li resonance line we are able to measure accurately the spatio-temporal dependence of the edge current density, a parameter of basic importance to the stability of high performance tokamaks. We discuss the basic atomic beam performance, spectral line-shape filtering, and polarization analysis requirements that were necessary to attain such measurements. Observations made under a variety of plasma conditions have demonstrated the close relationship between the edge current and plasma pressure, as expected from neoclassical theory.

*Work supported by the U.S. Department of Energy under DE-FC02-04ER54698.