Neutral atom imaging (invited) (abstract)

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The space plasma diagnostic technique of neutral atom imaging has its origins in the charge exchange analyzers developed for magnetic fusion. In both the space and laboratory applications, the objective is to detect and measure the energy spectrum of energetic neutrals escaping from a confined plasma. From an experimental standpoint, the technical challenges are similar: detect neutral atoms in the presence of intense charged particle and radiation backgrounds. With sufficient information about the spatial distribution of the neutrals and the plasma ions, it is possible to determine the ion temperature along the instrument's line-of-sight from the neutral atom energy spectrum. However, the push towards remote imaging of plasmas in the space community has led to the development of multiple line-of-sight neutral atom detectors. These instruments are essentially neutral atom cameras. While deconvolving the image information into ion temperature or ion density spatial profiles is problematic, neutral atom imagers can provide a unique perspective on the large-scale dynamics and structure of complex plasma systems such as planetary magnetospheres. The current status of space-based neutral atom imaging will be reviewed, including data from current missions and expectations for the IMAGE mission to be launched in early 2000. The IMAGE instrument will utilize a new technique involving submicron period, free-standing, transmission gratings that block ultraviolet light while permitting the passage of neutral atoms. It is possible to apply the techniques of neutral atom imaging to laboratory plasmas and a conceptual design for a three-dimensional, divertor neutral atom imager will be discussed. [S0034-6748(99)72701-2]

