Beams, Brightness and Background — Using Active Spectroscopy Techniques for Precision Measurements in Fusion Plasma Research[*]

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The use of an injected neutral beam — either a dedicated diagnostic beam or the main heating beams — to localize and enhance plasma spectroscopic measurements can be exploited for a number of key physics issues in magnetic confinement fusion research, yielding detailed profile information on thermal and fast ion parameters, the radial electric field, plasma current density, and turbulent transport. The ability to make these measurements has played a significant role in much of our recent progress in the scientific understanding of fusion plasmas. The measurements can utilize emission from excited state transitions either from plasma ions or from the beam atoms themselves. The primary requirement is that the beam "probe" interacts with the plasma in a known fashion. Advantages of active spectroscopy include high spatial resolution due to the enhanced localization of the emission and the use of appropriate imaging optics, background rejection through the appropriate modulation and timing of the beam and emission collection/detection system, and the ability of the beam to populate emitter states that are either nonexistent or too dim to utilize effectively in the case of standard or passive spectroscopy. In addition, some active techniques offer the diagnostician unique information because of the specific quantum physics responsible for the emission. In this talk I will describe the general principles behind a successful active spectroscopic measurement, emphasize specific techniques that facilitate the measurements and include several successful examples of their implementation, briefly touching on some of the more important physics results. I will conclude with a few remarks about the relevance and requirements of active spectroscopic techniques for future burning plasma experiments.