# ROLE OF BEAM FOIL SPECTROSCOPY IN UNDERSTANDING BASIC PLASMA PROCESSES ON THE SUN

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Beam-Foil spectroscopy(BFS) has proved to be a valuable technique for the determination of radiative lifetimes of excited atomic levels leading to the evaluation of the transition probabilities. The time- resolved nature of the decay process in a collisionless environment is a unique characterstic of the beam-foil light source. The relevance of BFS to astrophysics comes from the importance of radiative transition probabilities in the quantitative analysis of optical spectra. Stellar abundances are obtained from the intensity of a spectral line which essentially is a product of the abundance of the element in the source and the probability of the transition.Thus the evaluation of accurate values of transition probabilities contribute significantly to stellar abundance analysis.

The basic principle of BFS is that if a monoenergetic beam of fast ions is directed through a thin solid foil (often made of carbon having a typical thickness of 5-20μg/cm$^2$ ), the ions undergo excitation as well as further ionization or electron capture as a result of inelastic collisions between the atoms of the foil and fast ions. The emerging particles from the excited states decay spontaneously downstream of the foil. The ions are practically monoenergetic after the foil and their velocity v is known from the beam energy. In view of the excellent time resolution,each point x from the foil corresponds to a known time t after the excitataion. Thus the lifetimes τ of excited levels can be measured simply by recording the spectral line intensities I(x) as a function of x. If the excited level i decays only to one final level k, then the lifetime $\tau_i$ is simply the inverse of transition probability $A_{ik}$. If several final states are possible then:

$$\tau_i^{-1} = \sum_k A_{ik} \qquad \text{...........(1).}$$

In such a case the individual transition probabilities can be obtained from the branching ratios (1). One of the most serious problems that affect lifetime measurement is cascading which can be corrected by multiexponential program. The absorption oscillator strength (f-value) is related to transition probability as follows:

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$$f = 1.499\ \lambda^2\ (g_i/g_k)\ A_{ik} \quad .........(2).$$

where $\lambda$ is the wavelength (Å) of the transition, $g_i$ and $g_k$ are the statistical weights of levels i and k.

The spectroscopy division of BARC has developed the basic instrumentation for BFS experiments making use of the availble accelarators in BARC and TIFR. It consists of a half metre monochromator in a Czerny-Turner mount and one metre vacuum monochromator in a Seya-Namioka mount which was designed and fabricated indigenously(2) for carrying out the experiments in the Visible,UV and VUV region. The emitted light from the beam is viewed by the monochromators in the perpendicular direction to the beam. The signals from the monochromator exit slit are detected by the photomultiplier EMI 9789 QB using a peltier cooled housing. The output of the photomultiplier is analysed by a photon counting system consisting of a spectroscopy amplifier,discriminator and dual counter timer. In the VUV region a sodium salicilate coated photomultplier is used. The capability of this experimental set up was already demonstrated by investigating the beam-foil spectrum of the ions of oxygen produced in the 2 MV Tandem accelarator indigenously built in BARC. The details of the results can be seen in reference(3).

There is a strong local maximum of abundances of elements in the immediate neighbourhood of iron with iron itself at the peak in solar plasmas. Thus, these elements need lot of investigation,so that the data will be very valuable for understanding of basic plasma processes in the Sun. We wish to pursue the BFS studies further keeping the intersts of astrophysics in mind.

## REFERENCES

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