Forbidden transitions

Fe II	Garstang, R. H.	*Mon. Not. R. astr. Soc.*, **124**, 321, 1962; *Commun. Obs. London* no. 57, 1962.
Si, Fe	Garstang, R. H.	*Ann. Astrophys.*, **25**, 109, 1962.
Br II	Martin, W. C., Tech, J. L.	*J. opt. Soc. Amer.*, **51**, 591, 1961.

REPORT ON ELECTRON COLLISIONS

(Committee 2 continued)*

M. J. Seaton

Electron collisions are important in the atmospheres of hot stars, in gaseous nebulae and in the solar chromosphere and corona. In cooler stars, other collision processes may be more important; thus Pagel (**136**) argues that, in the solar atmosphere, $H^- + H \rightarrow H_2 + e$ is more important than $H^- + e \rightarrow H + e + e$. Reviews of all aspects of atomic collision work are given in (**8**) and (**64**). Reference (**64**) includes a review of electron collisions, by Heddle and Seaton, with an extensive bibliography of recent experimental and theoretical work. In the present report we consider aspects of electron collisions of particular importance in astrophysics.

I. *Accurate Calculations*

Most accurate calculations are made by using expansions in terms of unperturbed atomic eigenfunctions. This leads to coupled differential or integro-differential equations. It is only recently that it has been possible to solve such equations exactly when several states are included. Solutions of the *e*-H 1*s*-2*s*-2*p* equations (**23, 34, 134**) give 1*s*-2*s* and 1*s*-2*p* cross sections in rather poor agreement with those obtained experimentally (**53, 74, 101, 165**). Further work by Burke (**22**) shows that this is probably due to slow convergence of the expansions. Other methods should, therefore, be developed; an interesting approach is described by Presnyakov, Sobelman and Vainshtein (**64**). The expansion method is probably good when one has a group of closely coupled states, as is the case for transitions within ground-configuration terms. New calculations for configurations of 2*p* electrons are being made at University College, London, and calculations for 3*p* electrons are being made by Czyak (**64**).

For neutral atoms, cross sections are zero at threshold but for positive ions they are finite. When proper allowance is made for long-range potentials, calculations for positive ions should be more accurate than calculations for neutral atoms. A number of calculations of astrophysical interest have been made (**148**):

Mg^+, 3*s*-3*p* and Ca^+, 4*s*-3*d* (**149**); Fe^{13+}, $3p_{1/2}$-$3p_{3/2}$ (**14**);
O^{5+}, 2*s*-2*p* and Fe^{13+}, $3s^2\,3p$-$3s3p^2$ (**11**).
Na and Li sequences (**11**).

II. *Approximate Formulae*

One approach, applicable to optically allowed transitions, is to treat the collisional transition as an induced radiative process. The cross section may be expressed in terms of the oscillator strength f and an effective Gaunt factor $\bar{g}$ (**20, 8, 150**). In many cases, estimates good to within a factor of 2 may be obtained by assuming $\bar{g}$ to depend only on $\chi = (\frac{1}{2}\,mV^2)/\Delta E$; Van Regemorter (**150**) gives $\bar{g}\,(\chi)$ for neutral atoms and for positive ions. A more refined theory has

*Reference numbers in parentheses refer to the general bibliography which follows the report of the Commission.

https://doi.org/10.1017/S0251107X00014565 Published online by Cambridge University Press

been given for neutrals (158) and ions (Burgess, unpublished); and results have been tabulated for $n \rightarrow n + 1$ transitions in H (156). The method is least reliable when ΔE is large and when f is small.

Another approach is based on classical theory (Gryzinski, (62); Burgess, (64)). This is best when ΔE is not small. The method of Burgess and of Ochkur (133a) may be used for intercombination transitions.

III. *Experimental Work*

The main technical advance has been in obtaining improved energy resolution. Many cross section-energy curves show fine structure. References to experimental work on H, He, alkalis and other atoms are given in (64).

IV. *Ionization*

Taking account of all experimental results, Heddle and Seaton (64) give what they believe to be the best estimate of the H ionization cross section. Recent experimental determinations have been made for O (52). N (162) and alkali atoms (19). A major achievement has been the measurement of cross sections for positive ion ionization, He^+, Ne^+ and N^+ (41).

Improved techniques of calculation have been developed (58, 142), and accurate calculations have been made for hydrogenic ions (155) and for O^{4+} and O^{5+} (169).

V. *Recombination*

Burgess (21) shows that dielectric recombination has a large rate coefficient at high temperatures.

A SYNOPSIS OF MOLECULAR INTENSITIES

(Committee 2, continued)*

R. W. Nicholls

I. *Introduction*

Although this review is concerned mainly with intensity problems, it will not be out of place to mention some important identification aids which have recently become available:

The third edition of '*The Identifications of Molecular Spectra*' by Pearse and Gaydon (139) has been published, as has '*A Spectrophotometric Atlas of CH from* 3000–5000 Å' (6). The Bumblebee Report on OH has now appeared in the open literature (38) as have two very useful compilations of band head wavelengths by Wallace (173). An identificational Atlas of Molecular Spectra is in preparation (129).

Three general review papers on the concepts of molecular intensities may be mentioned (125, 133, 164a).

II. *Intensity Measurements of Molecular Spectra*

Relative or absolute intensity measurements in emission or absorption from photographic or photo-electric recording techniques have been reported for the following cases:

O_2 Schumann Runge (63, 97): O_2 Herzberg Continuum (40), NO (33, 179).
OH Vibration-Rotation (27, 57): OH Violet Bands (99).
N_2 Vegard-Kaplan (26): N_2 Second Positive, N_2^+ First Negative (174).
SiN (166): CN Violet (50): CO (109): C_3 (18).

*Reference numbers in parentheses refer to the general bibliography which follows the report of the Commission.