1969MSRSL..17

11. — CONSIDERATIONS ON THE FORBIDDEN LINES OF IRON IN THE STATES FROM Fe^0 TO Fe^{6+}

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ABSTRACT

The iron atom which has a fairly high cosmic abundance presents the great interest of appearing in a wide variety of stars and nebulae, at many stages of ionization, and of revealing forbidden transitions in emission in many of these ionization stages. The present paper discusses the following topics :

(a) the case of the as yet undiscovered forbidden lines of neutral iron (Fe^0) ;

(b) some recently acquired astronomical information on the forbidden lines of the stages Fe^+ to Fe^{6+} ;

(c) general considerations on the important information revealed by these forbidden lines of iron on the physical structure and excitation mechanisms which are present in the emission line stars of early and late types.

For lack of time we give only a very summarized version of our paper ; a complete text will appear later.

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In the usually covered spectral range (*), λ 3000 Å to λ 1 μ forbidden transitions of the following stages of ionization are observed : II, III, IV, V, VI, VII, X, XI, XIII, XIV, XV. Since Fe VIII, IX, XII, XVI and XVII have no forbidden line in the spectral range accessible from the ground, and since the ionization potential increases abruptly when passing from Fe^{16+} to Fe^{17+}, it appears that [Fe I] is the only forbidden spectrum of iron which has not yet been observed (P. Swings, 1951, 1952). In this paper we shall confine ourselves to the states from Fe^0 to Fe^{6+}. Of course it is known that the « coronal » transitions play also an important role in certain novae, but the ions from Fe^0 to Fe^{6+} are present in a greater number of objects, from the Be stars, the gaseous nebulae, novae and symbiotic objects to the long period variables and other cool stars.

To illustrate the striking difference in transition probabilities between the low ionization stages (up to Fe^{6+}) and the « coronal » stages (beginning at Fe^{9+}) we have collected in Table I the transition probabilities of a few of the strongest lines from [Fe II to XIV].

The probabilities of the characteristic lines of [Fe X] and [Fe XIV] are approximately one hundred times greater than those of [Fe VII to II]. This high probability ratio affects the influence of the density ; moreover the exciting radiation departs often from the black body type and presents strong discrete emission or absorption

(*) Of course strong emissions whose wave lengths lie shortward of λ 3000 may be shifted into the observable region in the case of quasars. Moreover, there are forbidden lines in the far ultraviolet and especially in the infrared (J. P. Swings, 1965a) which may play an important role : the [Fe II] transitions, in particular, may produce strong infrared emissions in planetary nebulae and Be stars. The transitions at 25.98 μ and 35.34 μ between the sub-levels of the ground a ^6D state may be of importance in various types of objects. Moreover, the infrared [Fe II] emissions may play a « cooling » role. A systematic discussion of all the forbidden and permitted lines of the iron ions in the far ultraviolet (in all the stages of ionization) would be of interest.

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