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Atomic Spectra. Special effort has been continued to obtain extensive and homogeneous descriptions of selected spectra in the lanthanide group of rare-earth elements. This work forms part of the basic research that must be done for the preparation of Volume IV of "Atomic Energy Levels."

The complex Ce I spectrum has presented serious difficulties, but at last the analysis has been successfully started. From a study of strong lines observed in absorption, and from observations of the Zeeman effect, the ground state has been determined as $4f\ 5d\ 6s^2\ {}^1G_4^{\circ}$ [1]. Several other low "odd" levels and more than 100 "even" levels are known. Additional measurements have been made from 4800 to 6180 Å, and selected Zeeman patterns are known to 7000 Å.

The Ce III spectrum has been observed and measured from 700 to 11 000 Å. Of the 2000 known lines, about 75% have been classified. The ground state is $4f^2\ {}^3H_4$ [2]. The strongest observed Ce III line, λ3055.589 Å may be present in the solar spectrum, and account for a faint solar line at 3055.594 Å which has hitherto remained unidentified [3]. If correct, this identification provides the only evidence of a third spectrum among solar lines>3000 Å.

Methods have been devised for making electrodeless lamps without carrier gas. Experiments have been conducted for exciting and separating first and second spectra and for producing self-reversed lines. These have been used to help conclude the extensive descriptions of Pr I and Pr II spectra from 2000 to 9000 Å. Zeeman observations of these spectra made at the Argonne National Laboratory have been measured and reduced, thus furnishing the *g*-values urgently needed for the analyses [4].

The analysis of Pr III has been published [5].

The atomic spectra of thulium produced by microwave excitation of thulium-iodide, and by sliding spark discharges between pure metal electrodes, have been photographed from 2300 to 11 000 Å. Zeeman patterns have been recorded to 8800 Å. Some 10 000 lines will be included in a new description of Tm I and Tm II [2], [6].

Measurements and calculations of Zeeman patterns of 1307 lines characteristic of Yb I, Yb II and Yb III spectra have been compiled preparatory to publishing a new description of these spectra comprising more than 6500 lines [6].

A paper entitled, "The Atomic Spectra of the Rare Earths; Their Presence in the Sun," summarizes the present state of progress on rare-earth spectra, and contains a long bibliography [3]. A more general reference summary is to be found in the Transactions of the Triple Commission for Spectroscopy held in September 1962 [7].

An extremely complete analysis of Br I is in press. This atomic spectrum stands out as one that has been most thoroughly observed and interpreted [8].

A theoretical paper on "Nonlinear Effects in the Spectra of the Iron Group" has been published [9].

Wavelength Standards. Work has continued on the measurement of interferograms of Kr^{86} and Kr^{84}. Progress is being made, also, with the development of emission sources for vacuum ultraviolet spectroscopy [10].

A new interferometric method has been used to study the hyperfine structure and isotope shifts of the Hg I line at 2537 Å [11]. The Zeeman-split absorption filter has been used with Hg^{198} and the wavelength compared with that from a Hg^{198} absorption beam [12], [13].

Spectroscopic Tables. Progress has continued with the derivation of experimental transition probabalities from the Monograph on Spectral Line Intensities. These data have been computed for some 25 000 lines of 70 elements [14], [15].

A new method has been developed for preparing computer data for publication. Programming codes have been written to control an automatic phototypesetting machine. This method has been used in the preparation of Monograph 53 [16].

The current revision of the 1928 edition of the solar spectrum is now partly in galley proof.

Work continues on the preparation of a new Multiplet Table.

The major advances since 1946 in standard wavelengths and intensities, in the quantum interpretation of atomic spectra, in spectroscopic apparatus, and in applications to chemical analysis, are discussed in a paper entitled "Review of Reviews of Atomic Spectra" [17].

The 180 MeV electron synchrotron has been used as a continuum light source for absorption spectroscopy in the region 180 to 470 Å. Two-electron transitions to states which autoionize have been observed in He, and transitions to autoionized states have also been observed in Ne and Ar. In He I eight lines have been attributed to $1s^2\,{}^1S_0$–$2s\,2p\,{}^1P^\circ_1$ and higher series members. In Ne I nine members of the series $2s^2\,2p^6\,{}^1S_0$–$2s\,2p^6\,np\,{}^1P^\circ_1$ have been detected, and in Ar I several observed features probably may be attributed to $3s^2\,3p^6\,{}^1S_0$–$3s\,3p^6\,np\,{}^1P^\circ_1$ [18].

The bibliographic card file of literature references on atomic spectra is kept up-to-date and critically evaluated. All of the extensive programs on atomic spectra mentioned above depend on the reliability and completeness of this file.

Collision and Photoionization Cross Sections. The absorption coefficient and line shapes of autoionizing double-electron transitions have been observed in helium, neon, and argon [18]. The dispersion-like shape of these absorption features is consistent with the theory of Fano [19], and the autoionizing levels have been identified [20].

The same transitions have been studied indirectly through measurements of the differential inelastic scattering of electrons on helium [21]. Work is continuing both experimentally [22] and theoretically [23] to understand these processes, which are not well described by an independent particle model.

Resonances in the total elastic scattering cross sections of helium [24] and neon [25] have been observed and interpreted. The total oscillator strength in the rare gas continua were reported [26].

The energy dependence for the photodetachment of electrons from negative atomic iodine ions has been carefully measured [27], following a preliminary determination of the threshold and total cross section [28].

Plasma Spectroscopy and Transition Probabilities. Experiments are in progress with wall-stabilized arcs to measure transition probabilities of some neutral oxygen, argon, and sulfur lines. In another arc experiment, the shapes and shifts of some oxygen lines were studied [29] and compared with recent Stark-broadening calculations which had been extended by Griem to a number of elements other than helium and hydrogen. The agreement for the linewidths is very good, but it is not satisfactory for the shifts. The good agreement in the widths suggests that the new line broadening calculations may be confidently applied to the diagnostics of dense plasmas.

With a magnetically driven shock tube (T-tube) measurements of the relative transition probabilities of a number of O II and O III lines were carried out [30]. The results agree well with the values obtained from the Coulomb approximation by Bates and Damgaard.

An apparatus for determining transition probabilities from measurements of the lifetimes of excited atomic states has been built, and preliminary measurements of lifetimes of several helium lines were undertaken which were consistent with previously determined values.

Calculations of f-values for the Li I sequence have been completed and accepted for publication [31]. The work on neutral helium is nearing completion. Exploratory calculations have been started on neutral carbon and nitrogen.

In the Data Center, work on the tabulation of the first ten elements continues, and an addendum to the Bibliography on Atomic Transition Probabilities, which covers all the recent work up to June 1963, has been assembled.

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(Note that contributions of NBS staff members at the Joint Institute for Laboratory Astrophysics, University of Colorado, Boulder, Colorado, are listed separately in the report from the JILA, following this report.)

Solar Physics and Solar-Terrestrial Relationships. The interrelation of various solar, geomagnetic, and ionospheric activity indices was analyzed to gain insight into the complex interactions of solar, optical and radio phenomena with solar particle emission. Delay times between solar outbursts and ground level cosmic ray events, polar-cap absorptions, and geomagnetic storms, and solar particle anisotropies were studied to provide bases for models of interplanetary magnetic fields [32–36].

CRPL continues to maintain a Solar-Geophysical Activity Service through contractual arrangements with several solar observatories. Thus patrol observations, both optical and radio, especially from locations in the western hemisphere are obtained. These observations help assure that there will be continuous 24-hour coverage of solar events. These are the events which help explain or are studies in connection with other geophysical phenomena. The experiments may be ground-based or in rockets and satellites.

Studies were made of the geomagnetic effects associated with balloon-borne x-ray counter evidence of auroral zone electron bombardment. Often the enhanced E-region conductivity created by and local to the particle precipitation could explain the rapidly varying features of the auroral electrojet current.

Earth's Ionosphere and Magnetosphere. A theory of two-stream plasma instability has been advanced as a source of irregularities in the ionosphere [37].

The intensity of extraterrestrial cosmic radio noise was observed on two frequencies at Palmer, Alaska, during the solar eclipse of July 1963. A technique has been developed whereby these observations can lead to a determination of the changing electron density profile of the ionosphere with varying illumination caused by the eclipse [38].

A numerical calculation of the shape of the outer magnetosphere boundary has been carried out for various solar wind pressures, and an investigation of the resultant geomagnetic field distortion is underway [39].

An investigation of the influence of magnetic storms on the motions of geomagnetically trapped particles is in progress [40].

Analyses of data obtained by the "Alouette" satellite are expected to give information about the distribution of helium and hydrogen ions in the outer atmosphere up to 1000 km [41].

Ionospheres of Other Planets. A theoretical study of the Martian atmosphere suggests that the Martian ionosphere occurs at a higher height and is less dense than the terrestrial ionosphere [42].

Radar observations of Venus were made at 50 Mc/sec at the Jicamarca Radar Observatory in November 1962. The relatively high signal-to-noise ratio made it possible to examine time variations in the returned signal of the order of tens of seconds [43]. Measurements of electron density out to two earth radii are continuing [44].

Terrestrial Airglow. A summary has been made of the night airglow data obtained during the IGY-IGC with particular emphasis on the physically intense but invisible (because of their color) arcs that occur in mid-latitudes during times of strong magnetic activity [45].

Calculations have been made which indicate that these mid-latitude red arcs are due to oxygen atom excitation by electrons which have been heated by local electric fields of the order of 1 mV/cm perpendicular to the magnetic field. Arguments are advanced that the fields are generated in the magnetosphere during magnetic disturbances [46].

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