II. SOFT X-RAY SPECTROSCOPY

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RESEARCH OBJECTIVES

The soft x-ray spectroscopy program has as its objective the experimental study of the structure of the conduction band of electrons in a series of metals, particularly the alkalis, alkaline earths, and some of the transition metals. The filled portion of such a band can be studied by observing the emission spectrum produced by transitions from this band to the nearest available sharp levels below this band. In most metals this corresponds to an energy in the range 15-250 ev (wavelength in the range 50-900 A), so that techniques of extreme ultraviolet vacuum spectroscopy need be applied. The energy widths of these bands usually lie in the range 2-10 ev.

In order to avoid the serious contamination of the metal that is being investigated, which arises in a conventional system, an ultrahigh vacuum (5×10^{-10} Torr) spectrometer has been constructed. Another feature of the device is the elimination of a grating as a dispersion element. This is accomplished through the use of a neutral atomic beam from which photoelectrons are ejected upon soft x-ray bombardment. The photoelectron energies are then analyzed with a low-energy electron spectrometer. This instrument is still under development.

Another objective of the group is to investigate metals in view of recent theoretical advances in the " many-body formulation " of solids. The experimental consequences of this theory should be evident in the volumetric photoelectric effect, in soft x-ray emission and absorption spectra, and in reflection and transmission experiments in this wavelength range.

An experiment performed recently on the volumetric photoelectric effect in nickel was nicely interpreted in view of the plasma oscillations in a metal, which are predicted by this many-body theory. A current effort is to observe plasma radiation from a thin film in which the valence electrons are undergoing collective oscillations. Further experiments along these lines are contemplated. A modification of existing apparatus is being made to allow ultrahigh vacuum conditions to prevail so that data obtained can be interpreted as being due to the metal specimen, rather than to contamination which so often obscures the results in the soft x-ray wavelength region.

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