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A joint scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the USSR Academy of Sciences was held on December 20 and 21, 1978 at the P. N. Lebedev Physics Institute. The following papers were delivered:

1. *B. I. Verkin and I. B. Svechkarev*, Weak magnetism as a method for studying the electronic structure of metals and alloys.

2. *I. K. Yanson and I. O. Kulik*, Microcontact phonon spectroscopy in metals.

3. *V. P. Galaĭko and V. M. Dmitriev*, Nonequilibrium superconductivity in specimens with small transverse dimensions.

4. *V. D. Fil'*, Electronic mechanism of acoustic-pulse transfer in magnetic fields.

5. *V. A. Yarba*, Superhigh-energy particle accelerators in construction and design stages.

6. *E. L. Feĭnberg*, Hadron clusters and semibare particles in quantum field theory.

We publish below brief contents of five of the papers.

B. I. Verkin and I. B. Svechkarev. *Weak magnetism as a method for studying the electronic structure of metals and alloys.* Along with the generally recognized Landau–Peierls contribution from states at the Fermi level, the constant component of the orbital magnetic susceptibility of the conduction electrons contains interband contributions from all occupied states of the spectrum. In principle, therefore, it can be used to probe the deep structure of the spectrum, i.e., to escape the limitations of traditional Fermi-surface investigations. Because of the extreme complexity of the theory, the role and properties of the interband contributions have been established experimentally in a group of simple (nontransition) metals and their alloys, where the presence of near-degenerate bands in the spectrum favors intensification of these contributions. For example, the following orbital-susceptibility properties that result from the presence of interband contributions have been established.[1,2]

1. Completely filled bands with small energy gaps possess anomalous diamagnetism.

2. Sharply defined susceptibility singularities whose form depends not so much on the nature of the change in Fermi-surface topology as on the actual structure of the near-degenerate bands correspond to the critical points of the spectrum (associated with electronic phase transitions of order 2-1/2).

3. The temperature of scattering-parameter range in which susceptibility singularities appear is determined by the size of the characteristic energy gap and is much wider than the corresponding range for oscillation and resonance phenomena.

The orbital contribution is a unique tool for detection of critical points in a system of near-degenerate bands, since the relative susceptibility modulation at the critical point may be several orders of magnitude higher than the corresponding singularities in the density of states.[2]

If the chemical-potential level is shifted by a suitable disturbance, the susceptibility can be used to determine the positions of the nearest critical points—first of all for bands with the smallest energy gaps—, the gap width and other parameters of the spectrum (from the amplitudes of the extreme values of the susceptibility, their temperature dependence, and the distance between critical points), i.e., entire fragments of the spectrum can be reconstructed. Since not only the observation of critical points, but also the details of their appearance, which depends on the structure of the related bands, is important in this spectral-analysis procedure, we may speak of a kind of magnetic-spectroscopic technique that does not, however, create real excitations in the spectrum.

The advent of an orbital-susceptibility theory that operates directly with the Hamiltonian matrix for near-degenerate bands[3] permits full exploitation of the possibilities of this technique. It can be illustrated with a whole series of examples.

Thus, the behavior of the susceptibility in alloyed tellurium has served as a check on the derivation of the theory and as a source of information on the relativistic constants of the Hamiltonian. A concentration (up to ~30 at.%) dependence of the energy gaps has been established in lithium-magnesium alloys, and the position of the critical point at which the Fermi surface touches the face of the Brillouin zone (19 at.%) has been

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found. The values of the spin-orbital and Coulomb splittings of three near-degenerate bands and the concentration dependence of the gaps and the chemical-potential level have been determined in alloys of cadmium with isovalent impurities (~10 at.%).[2,4] The characteristics of the scattering caused by the disorder of the potential have been found for the above systems. Rather far-reaching extrapolation of the spectral concepts that have been adopted for ideally ordered systems is found to be admissible when it is used to describe the electron structure of the alloys.

A critical point in degenerate bands of beryllium has been detected through the anomalous maximum in the diamagnetism even at ~800 °K, making it possible to determine the temperature dependence of the chemical-potential level up to $T \sim 1300$ °K.[5] As for the behavior of the chemical-potential level, the susceptibility properties indicate that its position in the middle of the energy gaps on the corresponding Bragg planes is the basic factor that stabilizes long-period superstructures in self-ordering alloys.

Detailed examination of these and other examples points to the conclusion that the parameters of the single-electron spectra of simple metals (especially the energy gaps, which are an immediate consequence of crystalline potential) can be determined with the aid of the orbital susceptibility with better accuracy than is obtained from existing *a priori* and empirical calculations of the spectrum, even when the Fermi surface is strongly diffused by temperature or scattering. We do not now have any other method capable of competing with the constant component of susceptibility in subtlety of electron-spectrum analysis over a broad range of concentrations and temperatures, and the latter can be recommended as an effective tool for investigation of disordered metallic systems.

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