Journal notes

Theory of Superconductivity

In quantum mechanics an electric current is closely connected with translational degeneracy. This is the reason why the difference between metals, insulators, and semiconductors can be qualitatively obtained from symmetry considerations assuming appropriate gaps in the energy spectrum. A systematic investigation of symmetry has shown that there is one more coupling case not previously considered, which leads to a model with the essential properties of superconductor. This model is described in terms of many-electron wave functions which correspond intuitively to electron lattices resonating between several equivalent positions.

The method is not adequate to prove whether the theoretical conditions of superconductivity are satisfied in actual cases. However, the assumption that they are satisfied in the two regions of the periodic table where the hard and soft superconductors are located fits in well with independent quantum chemical evidence. The London relation is given a quantum mechanical derivation. In contrast to these qualitative results Fröhlich's recent theory of superconductivity is quantitative, but at the price of using free electron wave functions.

We are apparently confronted with another instance of a many-body problem where the free particle approximation provides better results than theoretically expected (as in the case of "magic numbers" in nuclei). It may well be that Fröhlich's narrow electron beams exhibiting distance correlations are convenient approximations to the resonating electron lattices of the present theory. Whereas the free electron functions provide obvious advantages for explicit calculations, the many-electron functions may be superior for the understanding of the distribution of superconductors in the periodic table. L.T.

Theory of Superconductivity. By Laszlo Tisza. *Phys. Rev. 80: 719, November 15, 1950.*

Wavelengths of Mercury 198

The international standard of length, a platinum-iridium bar located in a vault at the International Bureau of Weights and Measures near Paris, was measured relative to the wavelength of the red cadmium line by Michelson in 1892, and the value he derived for the wavelength of the red cadmium radiation has been provisionally adopted as the international standard of length.

The advantages of Michelson's new standard were obvious: it was indestructible, more precise than the meter bar, and could be reproduced in any laboratory.

The Michelson lamp, however, is quite cumbersome and must be operated at elevated temperatures. A superior lamp would be one containing a pure, even isotope of high mass and low vaporization temperature. Such an isotope has been found in mercury 198, artificially prepared by neutron bombardment of gold 197. Its advantages as a universal standard of length are legion, but to name a few, its spectrum lines are extremely sharp, a milligram drop placed in a small glass tube yields an easily excited and compact source that can be operated at low temperatures, it is a simple spectrum and the intense green light at 5460 A corresponds to the maximum sensitivity of the eye.

The wavelength of the green line in the spectrum of mercury 198 has been measured to eight figures relative to the red line of cadmium and 26 lines in the spectrum of mercury 198 ranging from 2536 A to 5790 A have now been measured relative to the green line. When this green line is adopted as a primary standard of length, these 26 lines will serve as excellent secondary standards of length covering a wide region of the spectrum, and will be very useful in spectroscopy, metrology, and many other fields.

In the course of this investigation it was also discovered that all existing formulae for the dispersion of air in the ultraviolet region are in error, and a proposed series of determinations of the wavelengths of the above lines in vacuo and in standard air will yield a new formula that fits the observations.

The precise term values derived from these latest determinations of the wavelengths of the mercury 198 lines have shown that the wave number difference between spectroscopic energy levels as calculated from different spectrum lines involving those levels is constant to eight figures. A redetermination of these same wavelengths in vacuo should yield a check on the combination principle to nine figures, thus testing the discreteness of atomic energy levels with greater precision than ever conceived possible.

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Wavelengths of Mercury 198. By William F. Meggers and Karl G. Kessler. *J. Opt. Soc. Am. 40: 737, November, 1950.*

Spin Echoes

An ensemble of nuclear magnetic moments which freely precesses in phase in a large magnetic field at a given Larmor frequency will provide a nuclear induction signal. If suitable pulses of radio-frequency power at the Larmor frequency are applied to an ensemble, the necessary in-phase conditions can be established which make possible the detection of spontaneous induction signals. If the ensemble is made up of spins spread over a range of Larmor frequencies, it is possible to obtain free induction or "spin echo" signals due to the constructive interference of the freely precessing spins. An echo is observed to occur at a time after a pulse which is equal to the time interval between that pulse and a previous pulse. On the basis of transient solutions to Bloch's macroscopic nuclear induction equations, echo measurements provide a means for the direct and simple determination of relaxation time. A new method is available for the measurement of the self-diffusion coefficient of liquid molecules which contain precessing spins. The echo technique can provide information which is also obtained from steady-state methods, but has some technical advantages for certain applications because the driving radio frequency field is absent during the observation of nuclear signals. E.L.H.

Spin Echoes. By Erwin L. Hahn. *Phys. Rev. 80: 582, November 15, 1950.*

Thyratron Thermostat

Systematic phase-equilibrium studies have been of great value in exploring new systems involving the components of glass, refractories, metallic alloys, portland cement, and other industrial products. In order properly to employ this method of investigation, it is necessary that the specimen under study reach a state of equilibrium at any given temperature. To accomplish this, constant temperature must be