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*Work supported by the U. S. Atomic Energy Commission.
[1] H. Bohn, G. Kaindl, D. Kucheida, F. E. Wagner, and P. Kienle, Phys. Letters 32B, 346 (1970); and unpublished results.
[2] J. B. Mann, Los Alamos Scientific Laboratory, private communication (1970).

DG 6. A Method for Mössbauer Scattering following Coulomb Excitation.* J.A.HICKS, W.R.OWENS, and R.M.WILENZICK, Tulane Univ.--The use of Coulomb-excited targets as γ-ray sources for Mössbauer spectroscopy is required for the study of nuclides that have no suitable radioactive source. Practical considerations, such as low recoil-free fractions and long counting times, usually limit these investigations to γ-ray energies below about 100 keV. At present these studies have been made in transmission geometry, in which the "observed effect" is always less than the recoil-free fraction, f. In scattering geometry, the effect is f/B which can be very large if the background, B, can be minimized. The "in-beam" Mössbauer system at the Tulane Van de Graaff accelerator laboratory has been modified to allow measurements in a back-scattering geometry. A closed cycle helium refrigerator is used to cool the target and a conical-shaped scatterer. The arrangement has been tested by measuring Mössbauer spectra of the 122.6 keV γ-ray of ^{186}W using incident beams of 3 MeV protons and alphas. Experimental results will be presented and advantages, disadvantages, and limitations of the technique will be discussed.

*Work supported by the National Science Foundation

DG 7. Mössbauer Studies of Invar Alloys at High Pressures.* D. RHIGER, R.INGALLS, and D.L.WILLIAMSON, Univ. of Washington--Mössbauer spectra for ^{57}Fe in iron-nickel alloys of 30, 34, and 36 at.% Ni have been obtained at 94°K and 296°K for pressures up to 220 kbar. As pressure increases, collapse of the ferromagnetic spectra at 296°K confirms the well-known decrease of Curie temperature with pressure. In the 30 and 34 at.% alloys, a broadening of the paramagnetic line at high pressures gives evidence for the existence of a new magnetic phase having an ordering temperature that increases with pressure. Data on the location of the boundary of this new phase as well as the pressure dependence of the isomer shifts will be presented.

*Work supported by the United States Atomic Energy Commission under Contract No. AT(45-1)-1017.

DG 8. Extension of High Pressure Mössbauer Studies to 94°K for ^{57}Fe in Cu.* D.L.WILLIAMSON, R.INGALLS, and H.SHECHTER†, Univ. of Washington--The pressure and temperature dependence of the isomer shift (δ) and Mössbauer fraction (f) for ^{57}Fe in dilute solution in Cu was studied to 127 kbar and 94°K. The following pressure coefficients were obtained:

$$\partial\delta/\partial P)_{298°K} = -(5.18 \pm .49) \times 10^{-4} \text{ mm sec}^{-1} \text{ kbar}^{-1};$$
$$\partial\delta/\partial P)_{94°K} = -(5.93 \pm .47) \times 10^{-4} \text{ mm sec}^{-1} \text{ kbar}^{-1};$$
$$\partial f/\partial P)_{298°K} = (7.3 \pm 1.2) \times 10^{-4} \text{ kbar}^{-1};$$
$$\partial f/\partial P)_{98°K} = (3.3 \pm 1.2) \times 10^{-4} \text{ kbar}^{-1}.$$

These data are consistent with a Debye temperature of 322 ± 13°K.

*This work supported by the United States Atomic Energy Commission under Contract No. AT(45-1)-1017.
†Present Address: Physics Department, Technion, Haifa, Israel.

DG 9. Paramagnetic Relaxation Effects in Ferric Chloride Hexahydrate.* MORTON KAPLAN and THOMAS X. CARROLL, Carnegie-Mellon Univ. -- Mössbauer effect studies of polycrystalline and single crystal $FeCl_3 \cdot 6H_2O$ have been carried out in the temperature range 1.5-300°K. At the lowest temperatures, a symmetrical quadrupole doublet is obtained, confirming the assignment $|\pm 1/2\rangle$ as the ground Kramers doublet. At higher temperatures, the Mossbauer spectra become increasingly asymmetric as a consequence of the longer spin-spin relaxation times associated with population of excited states. The application of external magnetic field has a profound effect on the spectra. At 77°K, the asymmetry found in zero field decreases with increasing field, and a symmetrical doublet is observed at about 9 kgauss. At higher fields, however, an asymmetry develops in the opposite sense and is quite striking at 25 kgauss. In the helium temperature range, the external field induces a magnetization in the crystal, producing a hyperfine field which increases with applied field. The data are analyzed to yield the zero-field splitting, the orientation of the EFG, and the axes of magnetic fluctuations.

*Supported by the U. S. Atomic Energy Commission.

DG 10. Magnetic Ordering in $FeCl_3 \cdot 6H_2O$.* MORTON KAPLAN and THOMAS X. CARROLL, Carnegie-Mellon Univ. -- Polycrystalline and single crystal ferric chloride hexahydrate have been studied in the temperature range 1-4°K using the Mössbauer effect. The two-line quadrupole spectrum observed at the higher temperatures changes sharply to a six-line pattern as the temperature is lowered below 1.5°K. Repeated measurements demonstrate conclusively that $FeCl_3 \cdot 6H_2O$ undergoes spontaneous magnetization at 1.46°K, and exists in a magnetically ordered state below this temperature. Extensive data has been collected at temperatures between 1.1 and 1.4°K in externally applied magnetic fields from 0 to 24 kgauss, to elucidate the nature of the magnetic interaction in the crystalline salt. At constant temperature, the applied field causes the six-line spectrum to split into a twelve-line pattern, and the line positions change with increasing field. At the highest fields, the spectrum has "collapsed" into a six-line pattern again, indistinguishable from the zero-field data. A possible interpretation of these results will be presented.

*Supported by the U. S. Atomic Energy Commission.

Gravitation

EA1. The Gravitational Constant.
JESSE W. BEAMS, *University of Virginia*. (30 min.)

A brief historical review of the various methods of determining the Newton gravitational constant G will be given followed by a more detailed description of a new method presently in use at the University of Virginia.[1] The new method consists in mounting two large spherical masses symmetrically on a rotary table which can be driven about its vertical axis. Also mounted on the rotary table is a gas tight cylindrical chamber in which a small horizontal cylinder is suspended by a quartz torsion fiber fastened to the top of the chamber and hanging in the vertical axis of rotation of the table. The gravitational interaction between the spheres and the suspended cylinder tends to rotate the axis of the suspended cylinder into alignment with a co-planer line connecting the centers of mass of the two large spheres. An optical sensing-servo-system rotates the table in such a way as to maintain the angle between the axis of the horizontal cylinder and the line through the centers of the two large spheres constant to less than 0.5 sec of arc. G is determined from the constant angular acceleration of the table, etc. Preliminary measurements give a value of $G = (6.674 \pm 0.012) \times 10^{-11}$ N m^2/kg^2 where 0.012 represents three standard deviations. Variations in G of one part in 10^4 in several hours are not observed. By substituting more homogeneous material of different shapes for the mass systems and a magnetic support for the quartz fiber it is believed that a precision of one part in 10^6 in the value of G may ultimately be reached.

[1] J. W. Beams, A. R. Kuhlthau, R. A. Lowry and H. M. Parker, Bull. Am. Phys. Soc. 10, 249 (1965); R. D. Rose, H. M. Parker, R. A. Lowry, A. R. Kuhlthau and J. W. Beams, Phys. Rev. Letters 23, 655 (1969).

EA2. Sources of Gravitational Waves.*
REMO RUFFINI, *Princeton University and Institute for Advanced Study*. (30 min.)

Some remarks on the theory of gravitational waves and on their possible detection are presented, with an analysis of existing detectors. We discuss possible sources of gravitational radiation with particular reference to neutron stars and black holes. The spectral distribution of the radiation is analyzed for some special cases of interest.

*Work supported in part by National Science Foundation Grant No. GP7669.

EA3. Low Temperature Detectors for Gravity Waves.
W. O. HAMILTON, *Louisiana State University*. (30 min.)

The ultimate sensitivity of gravitational antennas is limited by noise. The noise can be due to non gravitational stimulation of the antenna from vibrations, electromagnetic excitation of the antenna and amplifier and detector noise. This type of noise can be reduced by careful design. The thermal noise in the detector itself causes the ultimate limit to sensitivity. Signals which transfer less than kT energy per unit bandwidth to the antenna can be observed by correlating responses of two isolated antennas but the ultimate sensitivity is still limited by the temperature. We will describe an experiment which is now under construction jointly at L.S.U. and Stanford where the temperature of the massive detectors will be reduced to below helium temperatures. The use of such low temperatures allows superconducting shielding of the antennas to insure complete isolation from electromagnetic excitation or interference. It allows magnetic support of the massive antennas which should result in greatly reduced vibrational coupling. Finally it allows the motion of the massive detectors to be monitored by a superconducting accelerometer, resulting in great stability and very low noise. The use of low temperature detectors together with correlation techniques should permit detection of gravitational collapses in other galaxies. Other gravitational wave experiments will be described.

EA4. The Gyro Test for General Relativity. W. M. FAIRBANK, *Stanford University*. (30 min.)

bulletin

OF THE AMERICAN PHYSICAL SOCIETY

NOVEMBER 1970

INCLUDING THE PROGRAM OF THE
1970 FALL MEETING IN NEW ORLEANS
23–25 NOVEMBER 1970

BULLETIN OF THE AMERICAN PHYSICAL SOCIETY

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HOW TO OBTAIN PREPRINTS OF PAPERS

The "abstracts" in this BULLETIN are not the abstracts of written texts of which we have the originals. These are the abstracts of speeches that are delivered at meetings of the Society. We have no texts, and those who wish more information than an abstract contains must write directly to the author.

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BULLETIN OF THE AMERICAN PHYSICAL SOCIETY

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1970 FALL GENERAL MEETING IN NEW ORLEANS, LOUISIANA
23—25 NOVEMBER 1970

PREAMBLE

The 1970 Fall General Meeting of The American Physical Society will be held in conjunction with the 1970 Annual Meeting of the Southeastern Section of The American Physical Society in New Orleans, Louisiana on Monday, Tuesday, and Wednesday, 23—25 November 1970. New Orleans was picked for the joint meeting because it has the desired academic and scientific influence, the appropriate housing and facilities for such a meeting, and also because of the many superb entertainment features available to visitors.

As its many boosters will tell you, New Orleans, with its combination of old world charm and new world enterprise is a truly distinctive American city. New Orleans is a city of fabulous food and fine restaurants. New Orleans' cuisine is a unique blend of culinary art from France, Spain, and the West Indies, with a secret or two borrowed from the Choctaw Indians. New Orleans is also good to the ear and to the eye. It has long been a center of classical music and more recently the city gave its name to quite another kind of music. Jazz was born on Basin Street and men who were there at the time still play in the region. Of great interest to visitors is the Vieux Carre—the French Quarter—where history has been halted and preserved. Its outdoor artists, its galleries, its restaurants, its old buildings, and patios paved with Europe's stones brought as ballast in long gone ships are well worth seeing. A map of downtown New Orleans showing hotels, restaurants and points of interest is printed elsewhere in this *BULLETIN*.

The headquarters hotel is the JUNG and all sessions will be held there. Room reservations may be made by using the form found elsewhere in this *BULLETIN*. If you have not made reservations, do so now. A guide to the location of the rooms in which the meetings are to be held can also be found in this *BULLETIN*.

The JUNG HOTEL is New Orleans' largest hotel and contains the largest convention facilities. It prides itself on "sensible" rates both for lodging and food. It is located at 1500 Canal Street—the nation's widest, most brilliantly lighted main thoroughfare. The hotel is within walking distance of the famous old New Orleans cemetery, the main business district, the Vieux Carre, and the Mississippi River. A restaurant, a rooftop swimming pool and terrace, the Fiesta Lounge, which features nightly entertainment, as well as other standard facilities are available in the hotel.

Registration will take place in the Convention Lobby of the JUNG (on the ground floor) on Sunday, 22 November, 4 P.M. to 10 P.M., and then all day Monday, Tuesday, and Wednesday. The registration fee will be $7.00 for members of either APS or SESAPS, $15.00 for nonmembers, $2.00 for physics graduate students, and physics undergraduates may register free at the Student Physics Society desk. There will be bulletin boards for announcements and for any additions or alterations to what is given in the *BULLETIN*. There will also be provision for posting messages; but the privilege of using it will be denied to those who do not register.

There will be no banquet at this meeting. In its place, a social event unique to some major river towns has been arranged. The steamship President, the world's largest sidewheel sightseeing steamship, has been rented from 5:30 P.M. to 9:00 P.M. on Tuesday, 24 November, for a river cruise party for registrants at the meeting and their guests. The ship will leave its dock at the end of Canal Street sometime after 5:30 P.M. and return there about 8:30 P.M. The return will be in ample time for those wishing to dine at some excellent restaurant to do so. During the cruise, hors d'oeuvres, cocktails, and live music will be furnished.