

XIII. GRAVITATION RESEARCH*

Academic Research Staff

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RESEARCH OBJECTIVES AND SUMMARY OF RESEARCH

The research effort in this group is in the field broadly labeled experimental relativity, in particular, experiments related to the gravitational interaction and measurable consequences of cosmological models.

Specific Research Activities

1. Balloon-borne far infrared radiometer experiment designed to measure the 3°K isotropic black-body background that is alleged to be a remnant of the cosmological "Big Bang." The radiometer was flown in a successful flight on September 29, 1969 and again on November 20, 1969. The last flight, however, ended in a catastrophe with the total loss of the apparatus. Preliminary results of the first flight indicate that (i) in the region between 6 cm^{-1} and 20 cm^{-1} the radiation does not follow a black-body spectrum, and (ii) the radiation by atmospheric water above an altitude of 39 km is not a problem in the experiment. At present, we plan to construct a new radiometer much as the original one, and also a low-resolution spectrometer to cover the same frequency spectrum.

D. J. Muehlner, R. Weiss

2. Long-term frequency stabilization of the Argon laser using a resonance absorption excited in a molecular beam as a primary reference. This project is the continuation of an experiment that uncovered a match between a resonance absorption in molecular iodine and one of the lines of the Argon ion laser. The present effort is on investigation of the short-term stability of the Argon ion laser. Another part of this project is an experiment to observe saturated absorption by iodine in an intracavity absorption cell.

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3. Gravitational vs atomic clock experiment to test the strong principle of equivalence, in particular, to search for evidence for the Brans-Dicke scalar gravitational interaction which violates the strong principle. In this experiment an atomic oscillator and a gravitational oscillator are both placed in a space vehicle. One measures the number of axis crossings of the atomic oscillator per axis crossing of the gravitational

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(XIII. GRAVITATION RESEARCH)

field as the space vehicle travels through varying gravitational potentials, for example, from Earth to Jupiter. If the strong principle is satisfied, the ratio of axis crossings is an invariant. But if the Brans-Dicke theory is correct, the ratio changes by a few parts in 10^8 between Earth and Jupiter. The design that was considered was a superconducting suspension of a triangular distribution of masses. This was the subject of a Master's thesis in instrumentation by Michael G. Blich. There are still some major, but not necessarily murderous, problems in the design. Further work continues with the collaboration of the M. I. T. Measurement Systems Laboratory and P. K. Chapman of the N. A. S. A. Manned Flight Space Center, in Houston, Texas.

4. A gravitational wave antenna to look for evidence of gravitational radiation by the Crab Nebula pulsar. Our intention is to use a pair of masses separated by a long distance, say, at first of the order of tens of meters. The separation of the masses is measured interferometrically. The interferometer output is used in a digital servo system to couple the masses such a way that it makes a very high Q resonator at twice the pulsar frequency.

A. Davidson

5. Index of refraction and birefringence of a magnetic field. If the theoretical work of T. Erber (Nature, No. 4770, p. 25, 1961) is correct, it may now be possible with pulsed magnetic fields and phase-locked lasers to observe vacuum polarization effects.

D. K. Owens