Supplemental Funding Request for Grant PHY 972212:

Development of Laser Interferometer Gravity-wave Detectors And Related Investigations

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The original proposal had main aims, which included:

(1) Extension of low-frequency performance of interferometers by

(a) Development of magnetic test-mass suspension as a way of achieving long suspension periods

(b) Development of techniques for coupling isolation systems at the ends of each interferometer arm, in position and tilt

(2) Development of diffractive-coupled interferometers, to allow higher light powers and wider choice of test mass materials.

In the current (second) year the grant is funding one fulltime person (an engineer), a one-quarter time technician, and part of the salary of the P.I., a Professor with teaching duties. With this limited manpower, it was decided to concentrate effort initially on (1) and postpone work on (2) till later.

Much has been achieved so far, and the work looks encouraging.

The present Supplementary Request has been triggered by a new possibility for reducing internal test mass noise, which has arisen in this research.

Possibilities for reducing Internal Thermal Noise
In Levitated Masses

In the original Proposal,

We proposed use of permanent magnets connected to test-mass material by high-Q posts or flexures, with special geometry to minimize thermal noise from relatively low-Q magnets over the beam area.

Other possibilities being considered:

(1) Levitation of sapphire (or other material) by its diamagnetism, in very high fields and field gradients.

(Demonstrated by A.K. Geim, and others, with water, biological, and other materials).

The very high fields raise severe problems for our application:

Not currently practicable with large samples;

Seems very hard to get practicable laser beam access at required fields.

Flux noise in such high fields can be important.

(2) Levitation of high-Q paramagnetic crystals. This may be done at significantly lower fields, so this seems more practicable. initial tests are beginning in our lab.

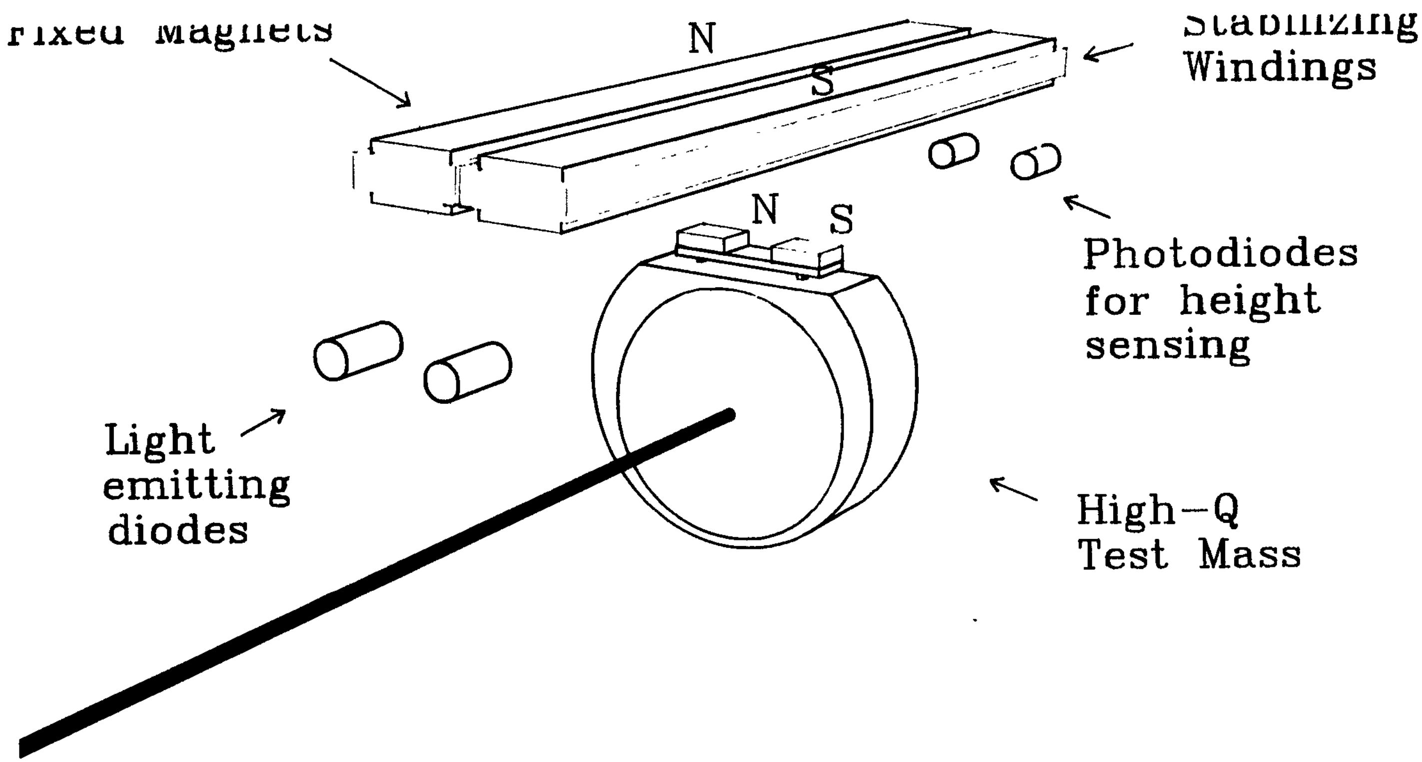
This looks like a new, and potentially promising, possibility. A levitated paramagnetic object is not intrinsically stable, but stabilization by a modified version of the servo systems we are using with levitated permanent magnets seems practicable.

If suitable high-Q materials are obtained, this could lead to important possibilities for test masses with low internal noise as well as low suspension noise, and thus in the long term lead to improved gravity-wave sensitivity.

In the shorter term both the paramagnetic and diamagnetic techniques we suggest here may lead to lower-noise magnetic control of orientation and fine position of fiber-suspended test masses.

Our current supplementary request is for a Post-Doctoral position and some additional auxiliary funding to enable these new developments, as well as our other work, to proceed effectively.

FIRST TEST 2-STAGE SYSTEM ~ BOTH STAGES LEVITATED.



Enlarged view of top of Test Mass

(POST FLEXURE VERSION)