CENTER FOR APPLIED PHYSICS STUDIES (CAPS)
LSC 3 MEETING
AUGUST 13-15, 1998

KATHLEEN JOHNSON/
ZENO GREENWOOD
(LOUISIANA TECH UNIVERSITY)

LIGO-G980113-03-M

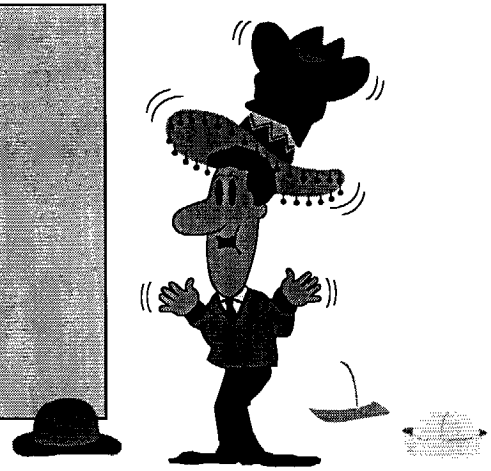
K. Johnston

Louisiana Tech University

Center for Applied Physics Studies

CAPS

"Maintaining an environment where world class multi-disciplinary physics research can be accomplished"

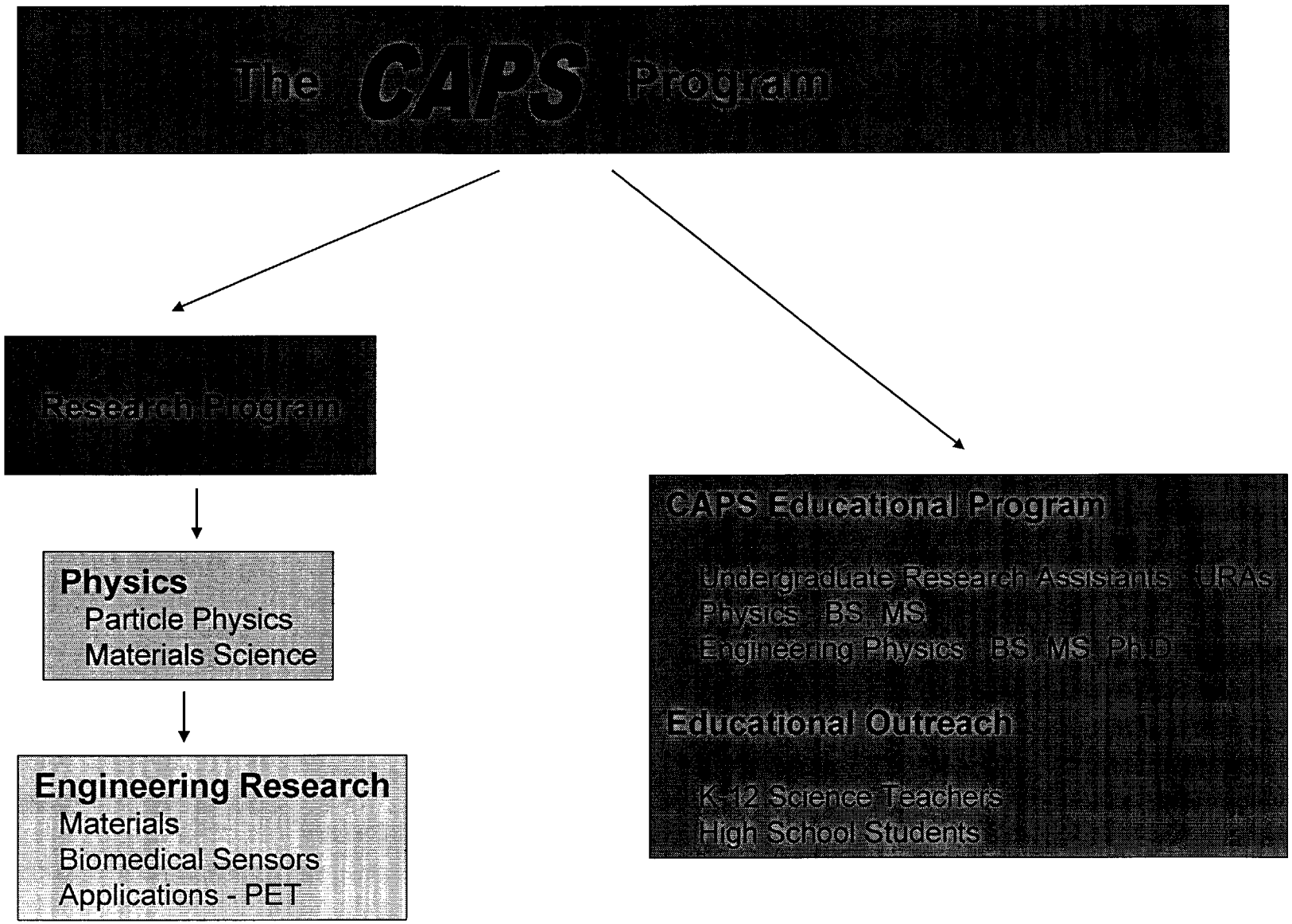


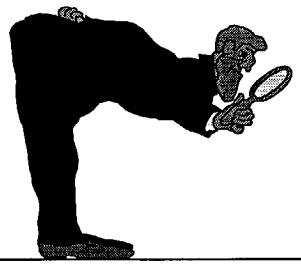
MISSION STATEMENT

The Center for Applied Physics Studies (CAPS) will endeavor to nurture an advanced physics and engineering research and educational environment that maintains scientific individuality while creating opportunities for inter-disciplinary studies and shared resources.

The Center will actively encourage and seek:

- World class research
- Methods of combining and making the most efficient use of all facilities and personnel
- Multidisciplinary team oriented environment
- Faster and more efficient transfer of new technology from basic research into the realm of applied sciences and engineering
- Educational opportunities that maximize the exposure of all types of students to cutting edge technology


The CAPS Program
Research Program
Physics
Particle Physics
Materials Science
Engineering Research
Materials
Biomedical Sensors
Applications - PET
CAPS Educational Program
Undergraduate Research Assistants (URAs)
Physics - BS, MS
Engineering Physics - BS, MS, Ph.D
Educational Outreach
K-12 Science Teachers
High School Students



CAPS Current Experimental Projects

The Physics Program

Research Coordinators Dr. K Johnston, Dr. N. Simicevic, Dr. Lee Sawyer, Dr. S. Wells, Dr. N. Zotov, Dr. Z. Greenwood, Dr. John Price, Advisors Dr. J. Maxwell, Dr. A Butler

- MARGIE - Minute-of-Arc Gamma-Ray Imaging Experiment
- G0 at TJNAF
- D0 Experiment at Fermilab

RApid Prototyping of Transition and Refractory materials - RAPTOR

Research Coordinators Dr. J. Maxwell, Advisor Dr. L Sawyer

- Direct growth of Segmented CsI crystal Arrays for coupling to the MARGIE CCD

Microminiature Refrigeration Development

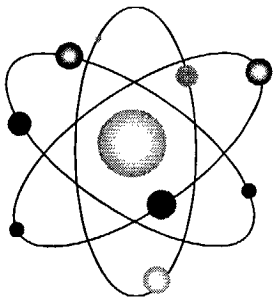
Research Coordinators Dr. H. Hegab, Dr. Steven Jones, Advisor Dr. S. Wells

- On-chip cooling for applications to electronics, specifically MARGIE CCD

Biomedical Sensor Development

Research Coordinators Dr. R. Keynton, Dr. J. Maxwell, Dr. J. Sunderland, Advisors Dr. K. Johnston, Dr. N. Simicevic

- Development of Metal Segmented CsI Arrays coupled to a Fast-timing bi-directional CCD for applications in PET and particle physics



La Tech CAPS Particle Physics Group

Faculty

Dr. Kathleen Johnston	Physics	Associate Prof.
Dr. Neven Simicevic	Physics/TJNAF	Assistant Prof.
Dr. Steve Wells	Physics/TJNAF	Assistant Prof.
Dr. Lee Sawyer	Physics	Assistant Prof.
Dr. Dick Greenwood	Physics	Assistant Prof.
Dr. Natalia Zotov	Physics/Math	Associate Prof.
Dr. John Price	Physics/TJNAF	Assistant Prof.
Dr. Susan Mohktari	Physics	Associate Prof.

Graduate Students

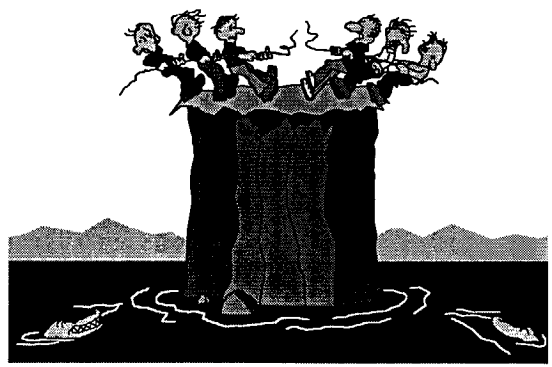
Craig Neerman	Research Asst.	MS in Physics, Summer 98	TJNAF E89-9
Liping Mo	Research Asst.	Ph.D. in ACAM, Spring 99	MARGIE
Brian Anderson	Research Asst.	MS Physics, Spring 99	TJNAF G0
Carl Ekblad	Research Asst.	Ph.D. Engineering Physics (entering Fall 99)	
Kevin Bethea	Research Asst.	MS Physics (entering Fall 99)	

Undergraduates

Carl Ekblad	Physics	MARGIE ADS, design, testing, code
Ethan Schrader	Physics	MARGIE
Ross Patrick	Physics	Sys. Manag.
Charles Murphy	Physics	LabView and DAQs
Clifton Vinning	ME	MARGIE, D0 Mech. Drawings
Chris Anders	Physics	D0 ICDs
Daniel Vinyard	EE	Electronics design for D0 ICDs
Anna Anderson	CS	Assembly of Hodoscope for E89-9
Bond Hutchinson	Physics	D0
Thomas Larry	Physics	MARGIE DAQ code development
Stacey Donaldson	EE	Web Master

School Teachers and Students

Ms. Michelle Bethea
Mr. Dirk Johnston
Ms. Cassy Labbato



CAPS Educational and Research Facilities

Computer System

6 Dec ALPHAs, UNIX
2 DEC Stations, UNIX
NT Windows Workstation
4 mm DAT
CD rom
Laser jet 4
Laser jet 3
Laser Jet 2
HP ColorPS
2 9 Gig HD Storage
20 Tektronics x-window
18 PCs
ATM Local Area Network

Detector Development Lab

CAMAC and VME DAQs
NIM Bin Electronics
LeCroy TDCs and ADCs
Electronics Design Station: PC based
- -Pspice Full Development Version
- -6 layer boards, 10,000 connections

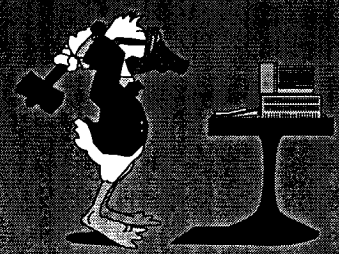
Electronics Assembly Station
- -electronics components, 2 layer boards
- -PS, protoboards, scopes, pulsers

Mechanical Design Station: PC based
- -AutoCAD 14

Cosmic Ray Test Stand
- -Scintillator, wire chambers, DAQ

Software Development Tools

AutoCAD Full Version
PSpice
Mathematica
MATLAB
LabView
PAW
MSOffice97



University Support and Facilities

Machine Shops: Bogard Hall and IfM

Administrative Support, Pam Witt

Technical Support, Tom Emory

Computer Support, Danny Schales and Bill Jones

Lab Facilities

Students: Matching Funds
Undergraduate Support - Undergraduate Research Assistantships - URAs
Graduate Student Support

Coming New "Engineering Physics" Program, BS, MS, Ph.D.
New Engineering Ph.D. Program
ACAM Ph.D. Program
Biomedical Engineering Ph.D. Program

The Center for Applied Physics Studies - CAPS - Faculty Associates

CAPS Associates Louisiana Tech	Title	Area Specialty	Cross Project
Dr. Kathleen Johnston	Assoc. Prof.	Particle Physics	Biomedical Sensors
Dr. Robert Keynton	Asst. Prof.	Biomedical Engr.	Particle Physics, MARGIE
Dr. Steven P. Wells	Asst. Prof.	Particle Physics	Microminiature Refrigeration
Dr. Lee Sawyer	Asst. Prof.	Particle Physics	Biomedical Sensors, PET
Dr. Neven Simicevic	Asst. Prof.	Particle Physics	Physics Materials Science,IfM
Dr. Hesham Hegab	Asst. Prof.	Mechanical Engr.	Physics Materials Science,IfM
Dr. James Maxwell	Asst. Prof.	Mechanical Engr.	Physics Materials Science
Dr. Zeno Greenwood	Adj. Prof.	Particle Physics	Biomedical Sensors
Dr. Natalia Zotov	Assoc. Prof.	AstroPhys/Math	
Dr. Steven N. Jones	Asst. Prof.	Biomedical Engr.	Materials Science, IfM
Dr. Ron Thomson	Prof.	Chemical Engr.	
Dr. John Price	Asst. Prof.	Physics	"to be determined"
Dr. Alley Butler	Asst. Prof.	Mechanical Engr.	MARGIE, G0, D0

CAPS Collaborator Associates

Collaborator	Affiliation	Tittle	Area Specialty
Dr. Micheal Cherry	Louisiana State University	Professor	Physics
Dr. John Wefel	Louisiana State University	Professor	Physics
Dr. Jerry Lisanti	Centenary College	Associate Professor	Physics
Dr. John Sunderland	Biomedical Research Institute Shreveport, LA	Research Scientist	Medical Physics
Dr. Rick Harmon	Computer Sciences Corp. Goddard	Flight Engineer Hubble Group	Engineer
Dr. Cindy Sisson	Louisiana State University Shreveport, LA	Assistant Prof.	Physics
Dr. Jerry Bida	Biomedical Research Institute Shreveport, LA	Research Scientist	Physical Chemist

Formal Application to join LIGO

Initial Personnel

Physicists:
Dr. Kathleen Johnston
Dr. Zeno D. Greenwood
Dr. Neven Simicevic
Dr. Lee Sawyer

Theorist who have expressed interest:
Dr. Natalia Zotov -
Gamma-Ray Astronomy
Dr. Susan Mohktari -
Quantum Gravity

Engineering Collaborators:
Dr. James Maxwell -
Mechanical Engineer,Director IfM, lasers and materials
Dr. Gary Zumwalt -
Geologists, site formations
Dr. Alley Butler -
Mechanical Engineer, control systems

We expect more later

Formal Application to join LIGO - MOU plus Attachment

Initial Personnel

Physicists:
Dr. Kathleen Johnston
Dr. Zeno D. Greenwood
Dr. Neven Simicevic
Dr. Lee Sawyer

Theorist who have expressed interest:
Dr. Natalia Zotov -
Gamma-Ray Astronomy
Dr. Susan Mohktari -
Quantum Gravity

Engineering Collaborators:
Dr. James Maxwell -
Mechanical Engineer,Director IfM, lasers and materials
Dr. Gary Zumwalt -
Geologists, site formations
Dr. Alley Butler -
Mechanical Engineer, control systems

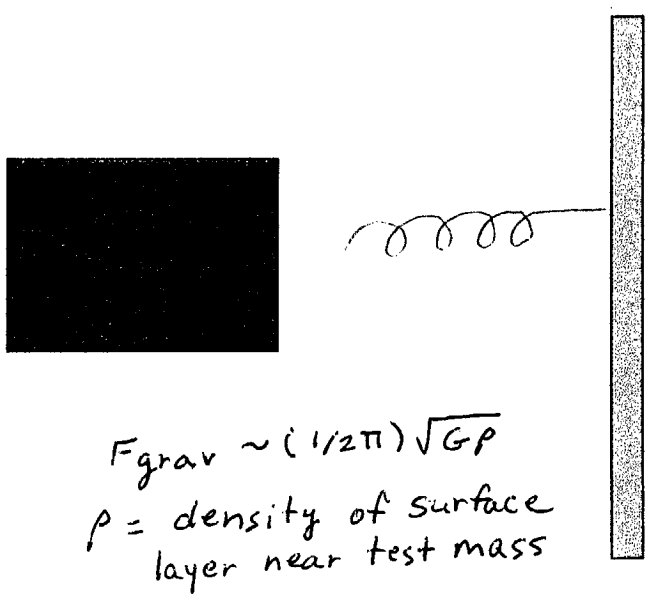
We expect more later

Seismic Gravity Gradient Noise

- Local gravitational noise due to variations with time in the distribution of matter near the interferometer
- Compression waves in the ground cause density gradients to be established near each test mass
- Transverse surface wave with vertical polarization add and subtract thin layers of material in horizontal plane

Gravity Gradient Noise (continued)

- As if test masses were attached to ground with spring:



Limiting Background for Advanced Interferometers

- 1st identified as potential background
  - R. Weiss, "Quarterly Report…M.I.T.",**105,**54(1972)
  - P.R. Saulson , Phys. Rev D **30** 734 (1982)
  - R. Spero, in *Science Underground* ,(1982)
- Recent Analyses
  - Scott Hughes and Kip Thorne, Phys. Rev.D ,(1997).
  - G. Cella and E. Cuoco, Virgo study, in press.

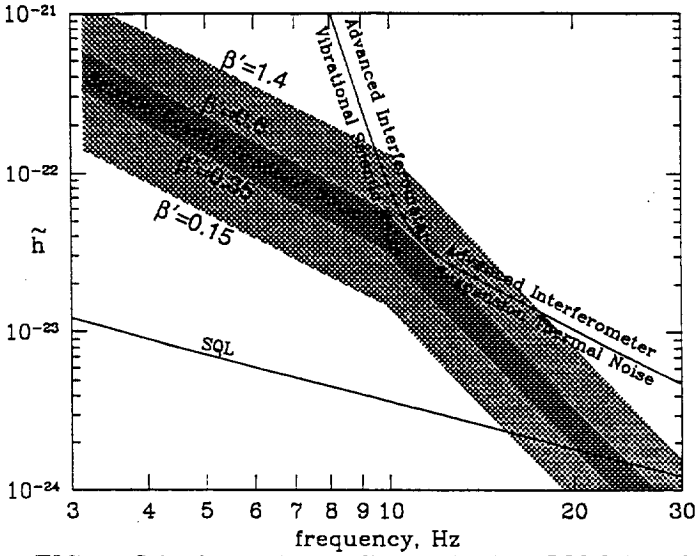


FIG. 2. Seismic gravity-gradient noise in a LIGO interferometer. In this figure, we assume that the direction-averaged spectrum of earth displacements has the form of the standard LIGO seismic spectrum, Eq. (1.27). The edges of the gray bands are for the indicated values of the reduced transfer function β' (assumed equal to β; *i.e.*, for γ and Γ approximated as unity). The dark gray band is our estimate of the range of noise for quiet times. The gray bands, both light and dark, are for noisy times, assuming the standard LIGO seismic spectrum (1.27). At very quiet times, the ground spectrum can be a factor ~ 10 smaller than (1.27), which will lower these bands accordingly. Conversely, at noisy times the ground spectrum can be larger, raising these bands. Also shown for comparison is the projected noise in an "advanced" LIGO interferometer, and the standard quantum limit (SQL) for an interferometer with one tonne test masses. The SQL is the square root of Eq. (122) of Ref. [39]. The "advanced" interferometer noise is taken from Fig. 7 of Ref. [1], with correction of a factor 3 error in the suspension thermal segment (Fig. 7 of Ref. [1] is a factor 3 too small, but Fig. 10 of that reference is correct, for the parameters listed at the end of the section "LIGO Interferometers and Their Noise").

$$= \frac{\beta'}{0.6} \frac{6 \times 10^{-23}}{\sqrt{\text{Hz}}} \left(\frac{10\text{Hz}}{f}\right)^4, \; 10\,\text{Hz} < f \lesssim 30\,\text{Hz}, \tag{1.29}$$

which we plotted for the indicated values of β'.

At very quiet times, the ambient seismic spectrum near 10 Hz can be as much as a factor ~ 10 lower than the standard LIGO spectrum assumed in Eq. (1.29) and Fig. 2, and correspondingly the quiet-time gravity gradient noise can be a factor ~ 10 lower.

At noisier times, there appear to be excitations of a variety of RF, RS and RP modes. For example, at the LIGO sites, time delays in correlations between surface motions at the corner and the end stations reveal horizontal propagation speeds $c_H \sim 5000$ m/s, corresponding to deeply seated RP-modes (although for the most part these modes are seen at frequencies too low to be of interest in this analysis — $f \lesssim 0.2$ Hz [23,24]). Moreover, the measured anisotropy ratios can fluctuate wildly from

LaTech Initial Efforts

- Attempt to characterize seismic gravity gradient noise at Livingston
  - Install a small surface array designed to determine the horizontal phase speeds that are present in the noise and how much noise is associated with each phase speed
  - Try to deduce the seismic modes that are present and their relative strengths--both at quiet times and noisy times
- Coodinate our efforts with the Livingston staff and Hanford staff and with the Penn State program (Gabriela Gonzalez).

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Note 1, Linda Turner, 08/20/98 10:49:34 AM
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Note 2, Linda Turner, 08/20/98 10:52:12 AM
Z. GREENWOOD