Aspen Winter Conference on Gravitational Waves and their Detection

Conference Summary

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Acoustic detectors

State of the art

- 3 to 8 mK noise temperature
- 6×10^{-19} burst sensitivity
- data gaussian to 8 to 10 σ
- long coincident data runs---Allegro cold from 91 to Jan 95
- real progress in sensitivity in parallel

Lessons

- detector quality determined by statistics of data
- real work is in eliminating non-gaussian and non-stationary noise
- real virtues in many detectors
- spectral analysis only gives one measure of performance

Future

- adiabatic changes in readout (improved squids)
- spherical ‘bars’: possibly the Mona Lisa of acoustic detectors
- correlation with interferometers---stochastic background searches

Interferometer Projects

AIGO	TAMA	GEO-600	VIRGO	LIGO	LISA
Australia, (India, China, Argentina)	Japan	Germany, Great Britain	France, Italy	USA	Europe, (NASA)
Australia	Japan	Germany	Italy	Washington, Louisiana	Space
Advanced technologies			Low frequencies	Multiple interferome-ters	Very low frequencies
400 m	300 m	600 m	3 km	4 km	5×10^6 m
planned	1995	1994	1995	1994	planned
1998	1998	1998	2000	2000	2015

Interferometer Subsystems, Technology

Seismic Isolation

- Passive systems: multiple pendulums (ANU, Pisa)
- Active systems (JILA)

Suspensions

- Low frequency (ANU)
- Double suspensions and control systems (Glasgow, Garching)

Thermal Noise

- Demonstration of Fluctuation-Dissipation theorem (Syracuse)
- Direct measurement of internal mode thermal noise (Caltech)

Optics

- Relationship of performance and optics quality (MIT)
- Availability of polishing technology

Lasers

- Nd-YAG (Stanford)

Interferometer Technologies...

Configurations

- 'Ordinary' but under control and aligned
- Recycling (power, signal, resonant, sloshing, chirped, coupled...)
- Sleeping beauties (triangle, delay line, Schellenbaum...)
- Diffractive princes (LOTS of possibilities)
- LISA: Practical but ambitious systems for space-based interferometers
- Satellite ranging

Ultimate Limits

- Squeezing: successes but reasons for pessimism
- Quantum non-demolition: successes and reasons for optimism

Infrastructure, engineering, reliability

- instruments worthless without them

Sources and how to detect them

Stochastic background

- Cosmic background, strings, or just too many white dwarfs
- LISA: spectral analysis of stationary noise
- Acoustic detectors, possibly with interferometers (narrow band)

Coalescing binaries

- More sky surveyed...not more binaries
- Optimal filtering: Knowledge is power
- With LIGO/VIRGO, $\delta\theta \approx 5$ degrees, $\frac{\delta D}{D} = 25\%$, $\frac{\delta M}{M} \approx 0.1\%$

Grand Challenge

- Need teraflop, teraword, terrible computers
- scheduled for 1 Jan 1999

Rapidly rotating stellar core

- axisymmetric, or two different bar-shaped scenarios
- Three possibilities from a simple problem

Low-Frequency sources

- massive BH binaries: mergers, seeds, collapse...
- can there be scenarios which do NOT give signals for LISA?

Data Analysis

Characterization of Noise

- spectrum, but also: histogram, kurtosis, etc.
- apply noise analysis to data, now, even from prototypes
- should not reinvent field: signal analysis experts

Characterization of detection

- agree in advance!
- multi-detector coincidence vs. multi instrument correlation
- detector optimization is a data analysis problem
- if the analysis is not good, have to build more sensitive instrument

LIGO Research Community

A structure to

- maximize the scientific opportunities with LIGO, to communicate data and coordinate analysis
- define modes of collaboration for research using LIGO, other detectors
- advise LIGO on the review of LIGO-related research proposals
- set up a bi-directional communication between LIGO and the research community

Process

- email to wide community of possible participants
- solicitation of comments, and nominations for the Nominating Committee for PPAC by Feb. 15, 1995
- provisional adoption of draft charter

International Gravitational Network

- international discussion and communication of global issues
- definition of data protocols, coordination of detector observational periods, and joint technology sharing
- requires agreements among projects
- recommend that leaders assemble during 1995 to initiate formation of an International Gravitational Network
- target: GR14 (Florence) in August, 1995