

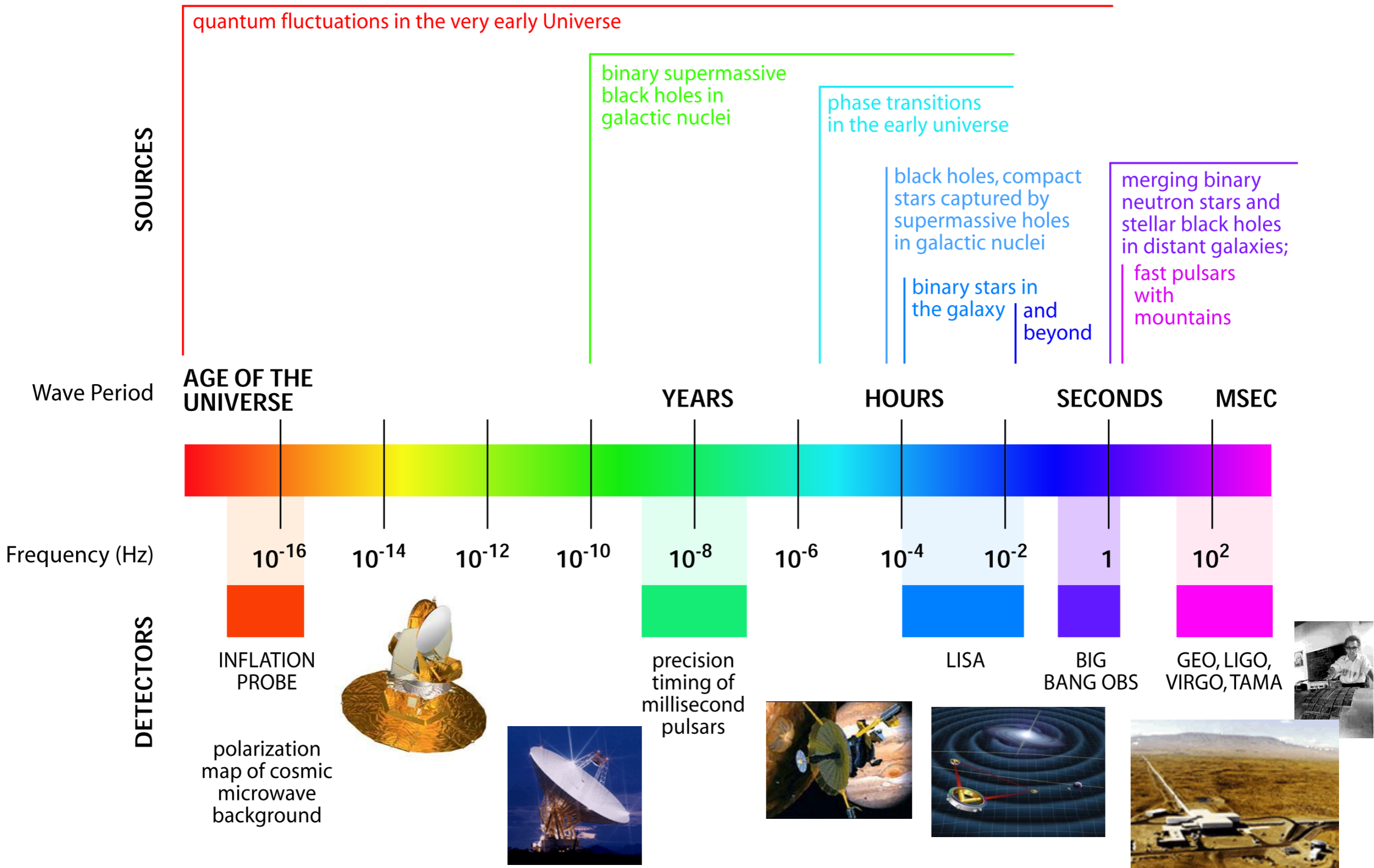
# International Gravitational-Waves Outreach Group



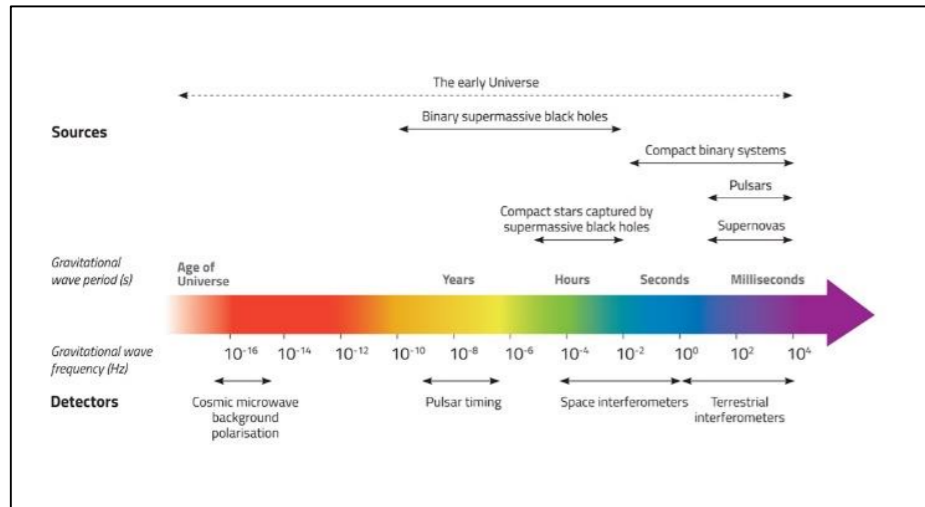
## SATELLITE MEETINGS

1. Spanish-Portuguese Relativity Meeting (EREP2019), July 6, 2019, Valencia (Spain).
2. [International Gravitational Waves Outreach Group Meeting, July 13, 2019, Valencia \(Spain\). Link >](#)
3. Gravity: New perspective from strings and higher dimensions, July 16-24, 2019, Benasque (Spain). [Link >](#)
4. International Congress on Industrial and Applied Mathematics (ICIAM2019), July 15-19, Valencia (Spain). [Link >](#)
5. XXXVII Reunión Bienal de la Real Sociedad Española de Física, July 15-19, Zaragoza (Spain). [Link >](#)

# THE GRAVITATIONAL WAVE SPECTRUM



# Working in partnership...



**NEW event**  
25 Apr 2018

**A walk through the Cultural Collisions exhibition in the Ontario Science Centre**

"Cultural Collisions" is an interdisciplinary exhibition, lecture and workshop series based on the art@CMS methodology. The "Cultural Collisions in Canada" event creates a learning experience for students and teachers to integrate Science and the Arts. It is a novel concept and an innovative and experimental collaboration in itself. ORIGIN is a network involving several Astrophysics and High Energy Physics experiments and research centres. ORIGIN's purpose is to setup national Cultural Collisions learning and research experiences, in close partnership with local institutes, educators and decision makers.

CulturalCollisionsCanada exhibition OSO Science

Thank you to the Ontario Ministry of Education

share



**Cultural Collisions by/par Origin-Canada**

Thank you to the Ontario Ministry of Education and all ORIGIN - Canada partner



# LSC: a global community

As of 2019-07-01:

- 125 institutions on 5 continents (ligo.org)
- 1854 members (roster.ligo.org)
- LIGO mainly funded by US-American NSF (with significant contributions from UK, Australia, Germany)
- instrumental R&D, computing, data analysis, astrophysical interpretation, **and public outreach** all benefit hugely from international contributions
- LSC outreach always needs to span audiences from the local to the global levels.



*From David Keitel's LSC talk on Monday*

# LSC education & public outreach

- from the original LSC charter (2005):  
*“...carry out an outreach program to communicate LIGO’s activities and goals to the public, and to provide educational opportunities for young people”*
- official EPO group established 2008
- current chair: Martin Hendry (Glasgow),  
former chairs: Marco Cavaglia, Szabolcs Marka, Joey Key



- EPO activities are part of LSC member group’s MoUs and overall LSC program

the pillars of...

LSC EPO

LLO  
LHO  
GEO  
  
tours  
&  
edu-  
cation  
  
centers

formal  
  
edu-  
cation  
  
schools  
colleges  
& unis

f2f  
  
fairs  
  
conf  
eren  
ces  
  
etc.

media  
  
con-  
tacts

politi-  
cal  
  
out-  
reach

online  
ligo.org  
  
social  
media

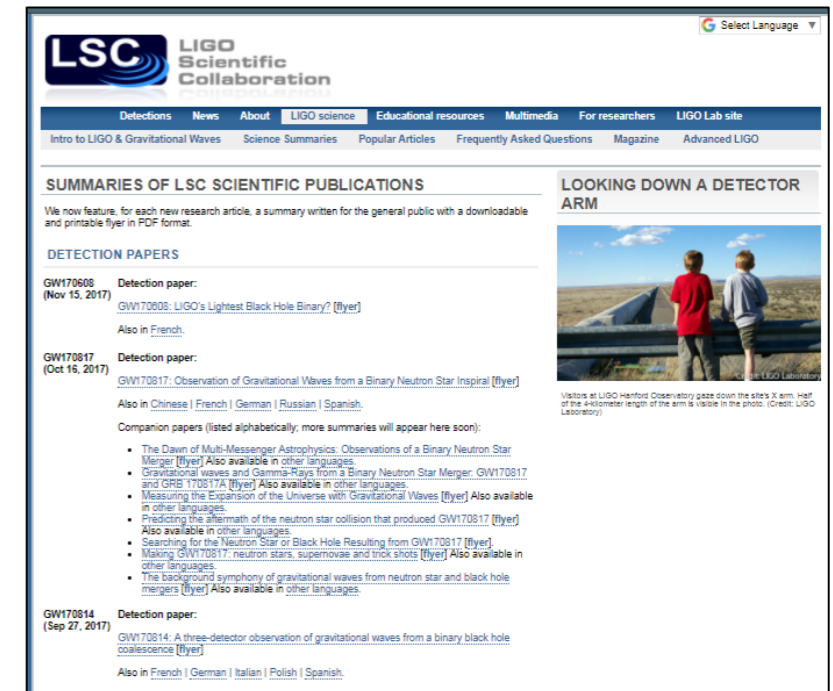
NEW  
  
public  
GW  
alerts

volunteers

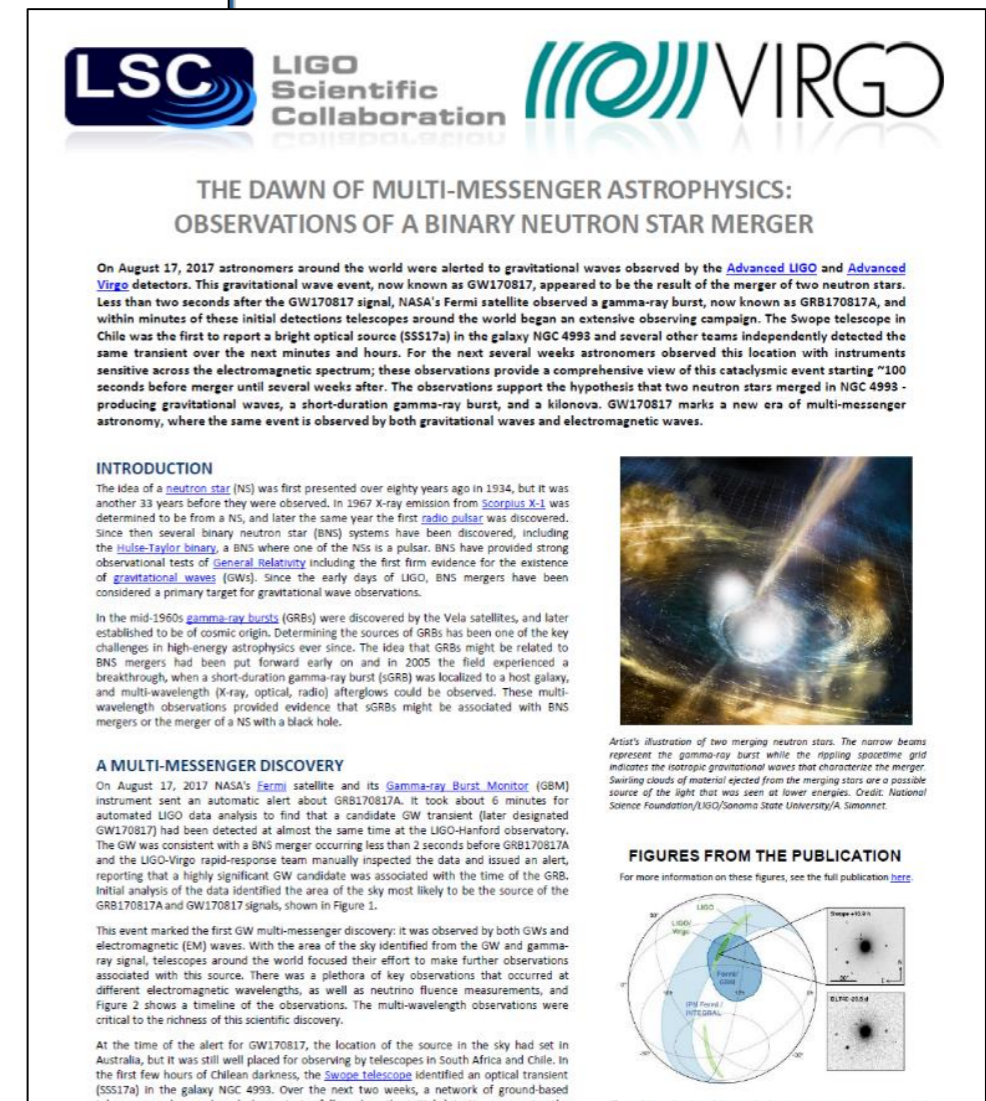
*(and some great professional  
staff at LLO, LHO, CIT)*

# Science summaries

- *one of our key EPO products.*
- web page summaries of published papers; also pdf “flyer” versions for handouts at booths/ events.
- produced by members of paper writing teams and further edited by EPO.
- translations (~5 languages) for detection summaries.
- **More than 90 summaries since 2011**
- Now core part of PWT responsibilities
- Focus for e.g. press interest, enquiries

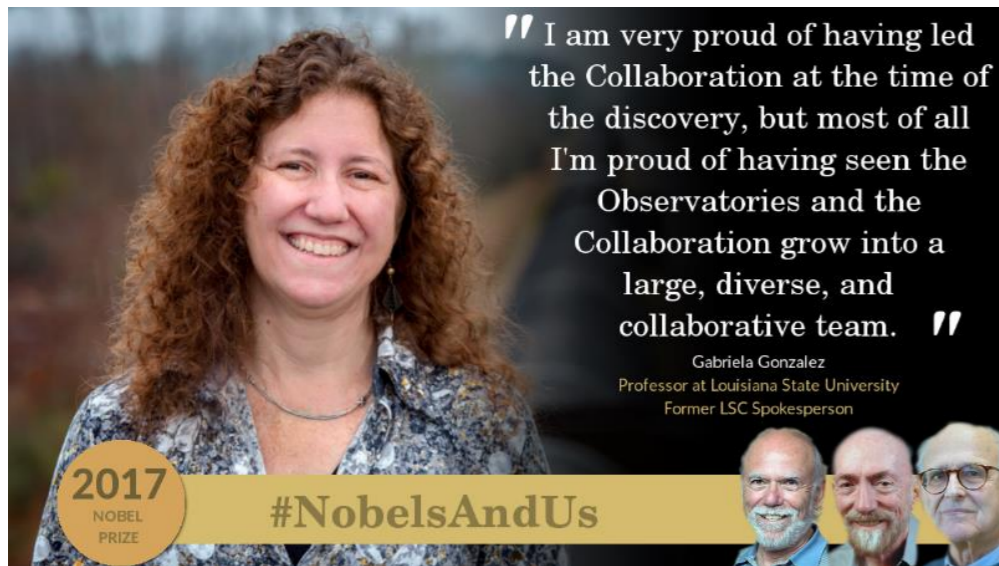
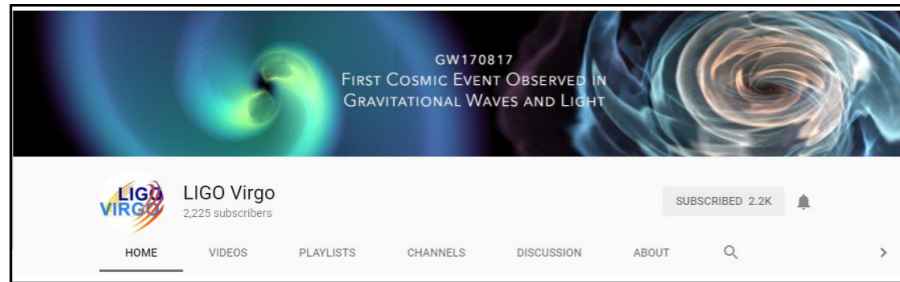


The screenshot shows the LIGO Scientific Collaboration website. The header includes the LSC logo and navigation links for 'Detections', 'News', 'About', 'LIGO science', 'Educational resources', 'Multimedia', 'For researchers', and 'LIGO Lab site'. Below the header, there are sections for 'SUMMARIES OF LSC SCIENTIFIC PUBLICATIONS' and 'LOOKING DOWN A DETECTOR ARM'. The 'DETECTION PAPERS' section lists several papers, including GW170608 (Nov 15, 2017) and GW170817 (Oct 16, 2017). Each entry includes a title, a link to the paper, and a list of languages available for translation. A small image of two people looking at a detector arm is also visible.



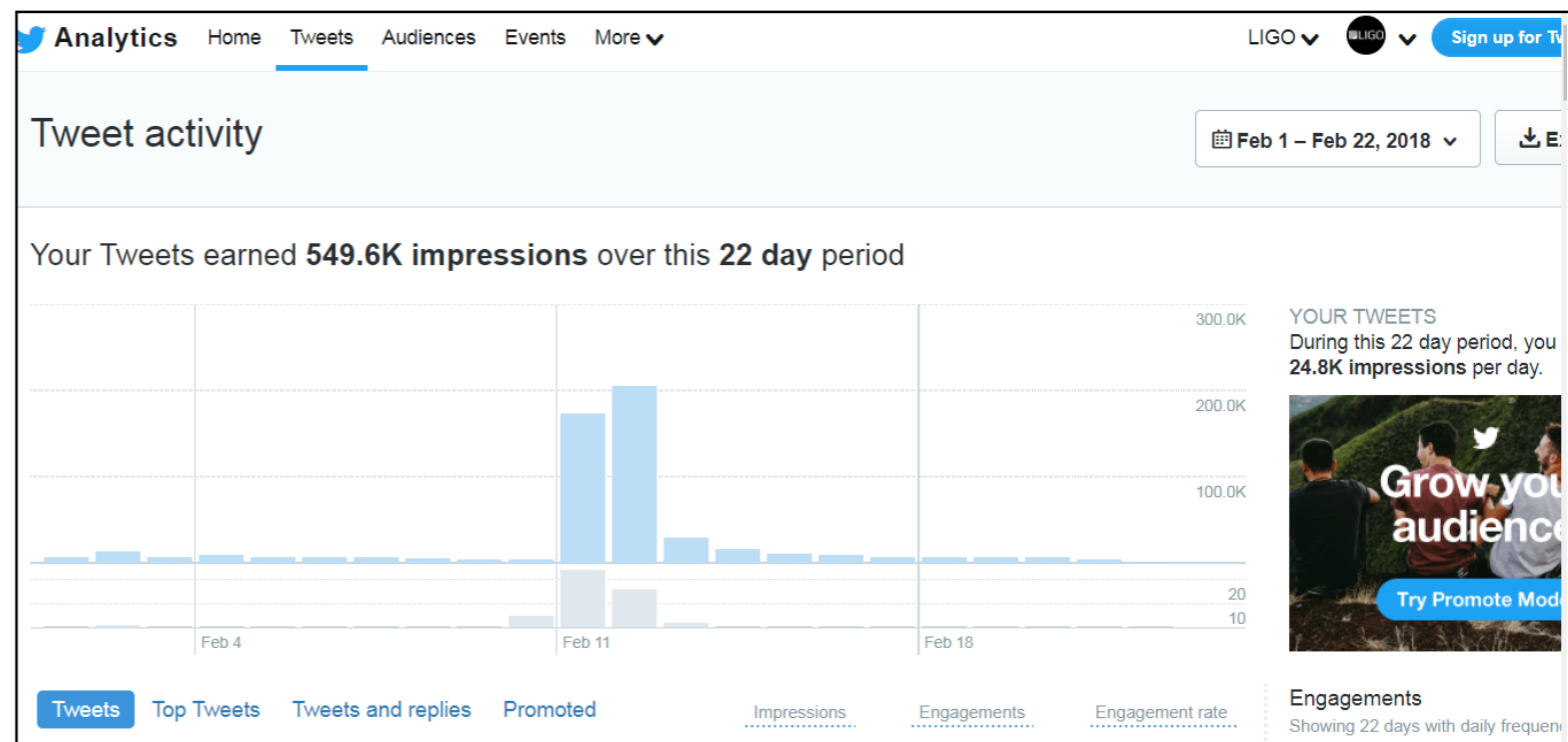
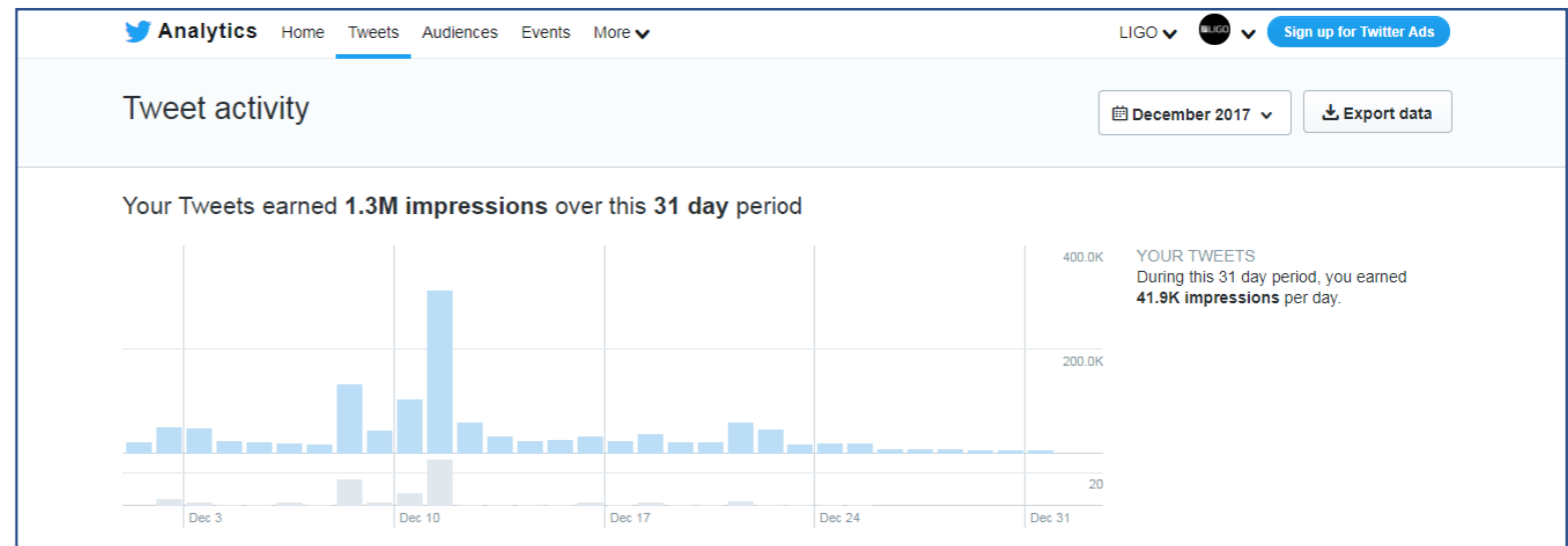
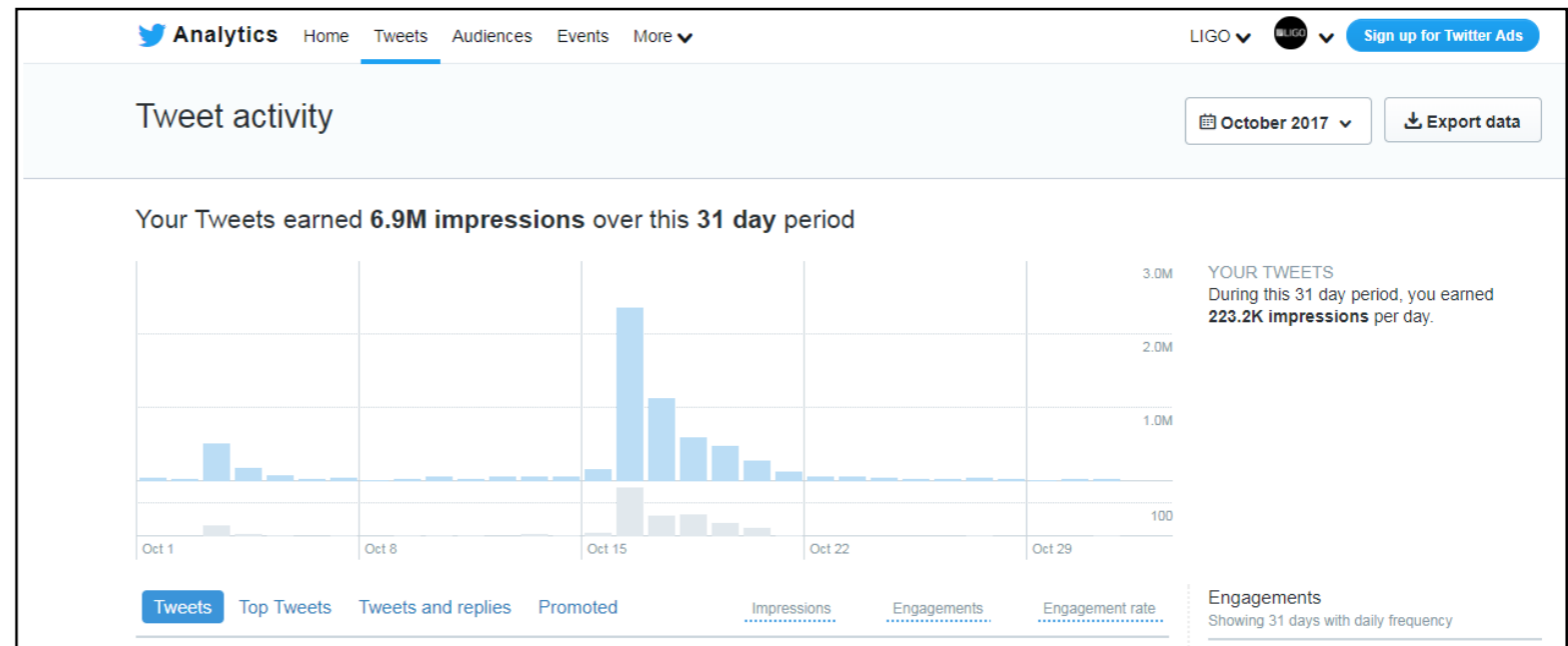
The flyer features the LSC and VIRGO logos at the top. The title is 'THE DAWN OF MULTI-MESSENGER ASTROPHYSICS: OBSERVATIONS OF A BINARY NEUTRON STAR MERGER'. The main text describes the discovery of a binary neutron star merger on August 17, 2017, observed by LIGO and Virgo detectors, with a gamma-ray burst detected by NASA's Fermi satellite. It highlights the multi-messenger nature of the event, involving gravitational waves, gamma-rays, and optical observations. The flyer includes an 'INTRODUCTION' section, a 'A MULTI-MESSENGER DISCOVERY' section, and 'FIGURES FROM THE PUBLICATION' which includes a sky map and two astronomical images. An artist's illustration of two merging neutron stars is also present.

# EPO Social Media:



We have improved social media coordination with laboratories, institutions, consortia and other GW projects.

**Current focus is on social media support for O3 public alerts**





<https://humansofligo.blogspot.com/>



# HUMANS OF LIGO

[SUBSCRIBE](#)

[SEARCH](#)

Short profiles of people involved with the Laser Interferometer Gravitational-Wave Observatory

[HOME](#) · [ABOUT](#)

Pages

[Home](#)

[About](#)

Archive



Labels



# online: Humans of LIGO

[humansofligo.blogspot.com](http://humansofligo.blogspot.com)

- highlighting the humans behind our science
- with a focus on:
  - younger members
  - under-represented groups
  - people with unusual career paths or hobbies
- recognition for the founding human

LATEST POSTS



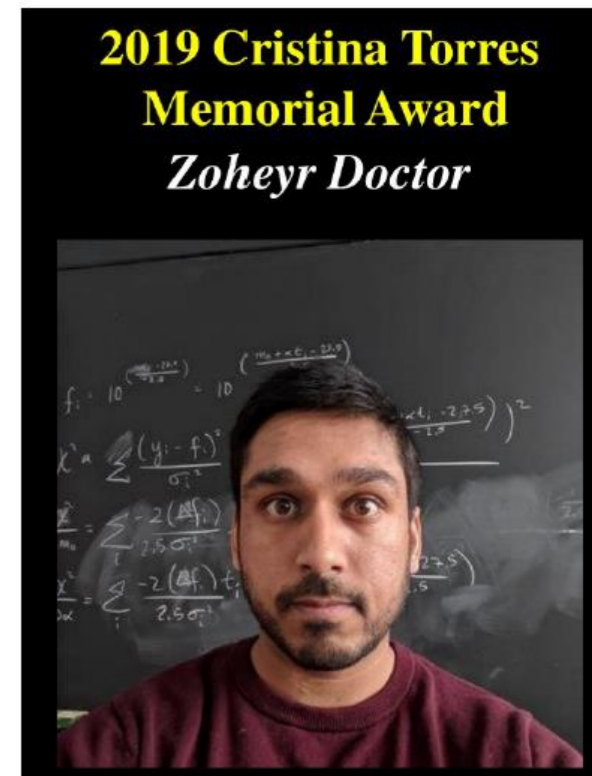
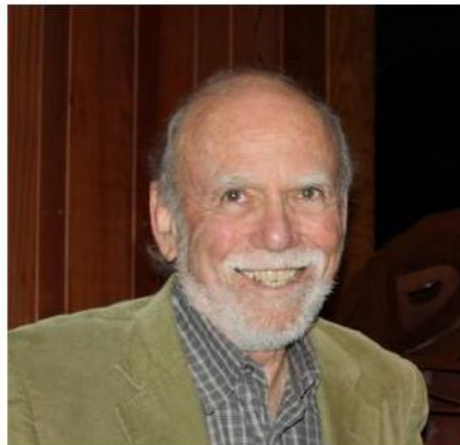
May 13, 2019  
**SUDARSHAN GHONGE**  
Post a Comment



April 19, 2019  
**DENYZ MELCHOR**  
Post a Comment



April 09, 2019  
**JAX SANDERS**  
Post a Comment

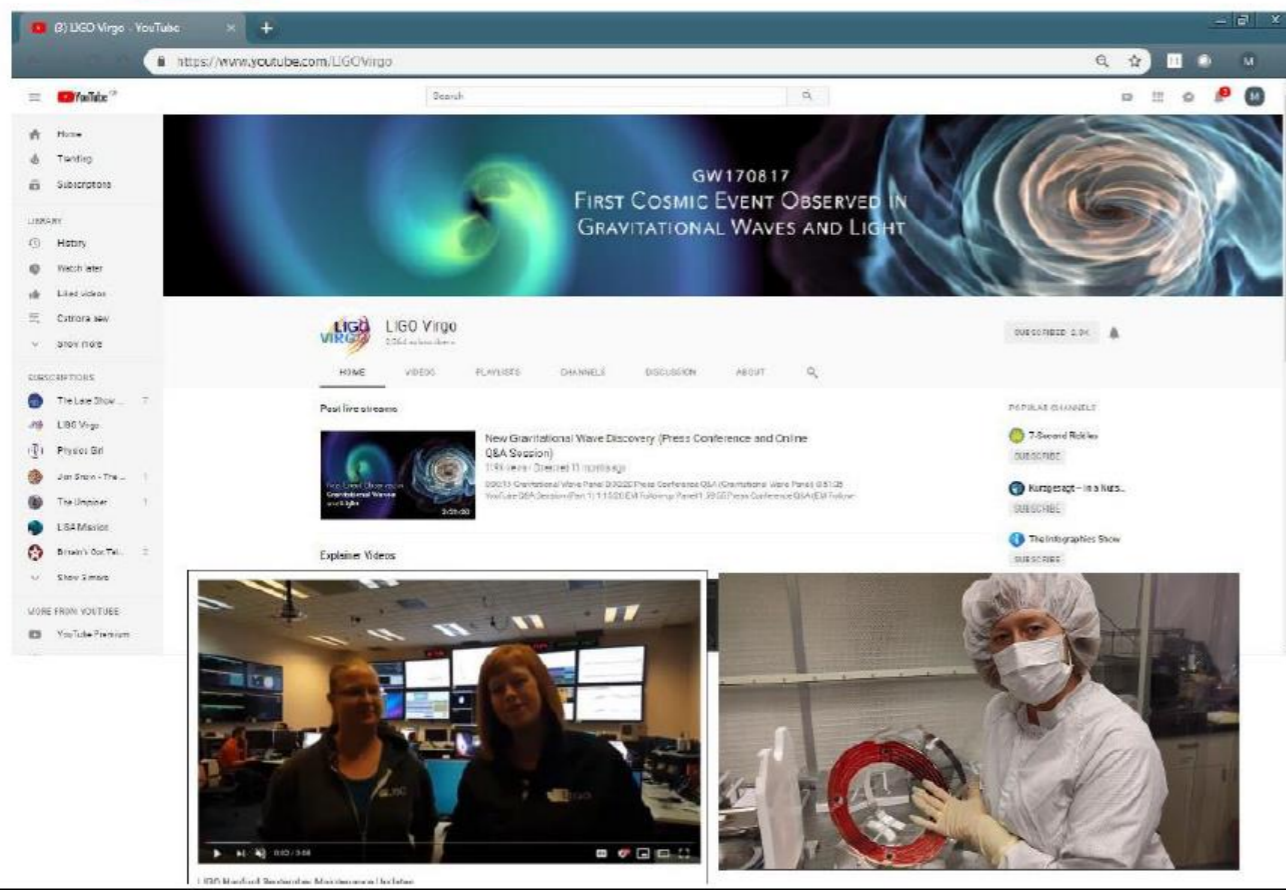


# online: videos

- two main dissemination channels:
  - ligo.org
  - youtube.com



<http://youtube.com/LIGOVirgo>



## MULTIMEDIA

Visit the [LIGO-Virgo Youtube channel](#) for documentaries, explainers, talks, and more! Also check out videos and audios below.

## VIDEOS, AUDIOS

### LIGO PRIMER

Watch the videos in this section to learn about what gravitational waves are, how they will be detected, and where they come from.



- great materials (e.g. NR visualisations) also on member group YouTube pages
- special mention to Kai Staats:  
→ [vimeo.com/kaistaats](https://vimeo.com/kaistaats)

# online: support of LVC public alerts

- #O3ishere – LVC now delivering public low-latency GW alerts to all professional and amateur astronomers, to maximise multimessenger science opportunities
- for scientists: GCNs and [gracedb.ligo.org](https://gracedb.ligo.org) database
- detailed info for astronomers: [emfollow.docs.ligo.org/userguide](https://emfollow.docs.ligo.org/userguide)
- for full scientific scope, see K.Chatziioannou's plenary talk (Tue 12:00)

Credit: LVC/MPI-GP/Abhirup Ghosh

MAY 2019						
SUN	MON	TUE	WED	THU	FRI	SAT
			1	2	3 X	4
5	6	7	8	9	10 X	11
12 X	13 X	14	15	16	17 X	18
19 X	20	21 X	22	23	24	25
26	27	28	29	30	31	

The calendar shows dates 3, 10, 12, 13, 17, 19, and 21 marked with a large black 'X'. Red arrows form a path starting from the 3rd, going to 4, 10, 11, 17, 18, 24, 25, 21, 20, 13, 12, 19, and 26.



## Navigation

[Getting Started Checklist](#)

[Observing Capabilities](#)

[Procedures](#)

[Alert Contents](#)

[Sample Code](#)

[Change Log](#)

[Glossary](#)

[Question? Issues?](#)

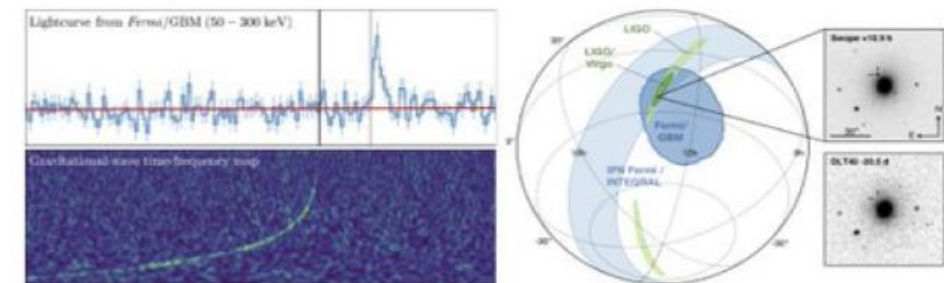
[Feedback?](#)

Email [emfollow-userguide@support.ligo.org](mailto:emfollow-userguide@support.ligo.org)

[Quick search](#)

[Getting Started Checklist](#)

## LIGO/Virgo Public Alerts User Guide



Welcome to the LIGO/Virgo Public Alerts User Guide! This document is intended for both professional astronomers and science enthusiasts who are interested in receiving alerts and real-time data products related to gravitational-wave (GW) events.

Three sites (LHO, LLO, Virgo) together form a global network of ground-based GW detectors. The LIGO Scientific Collaboration and the Virgo Collaboration jointly analyze the data in real time to detect and localize transients from compact binary mergers and other sources. When a signal candidate is found, an alert is sent to astronomers in order to search for counterparts (electromagnetic waves or neutrinos).

# Exhibits



## Astronomy's new Messengers Listening to the Universe with Gravitational Waves

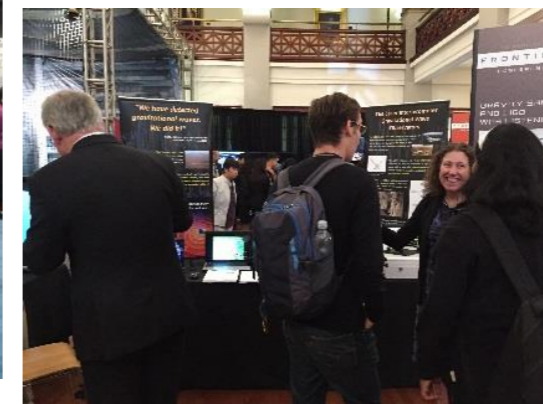
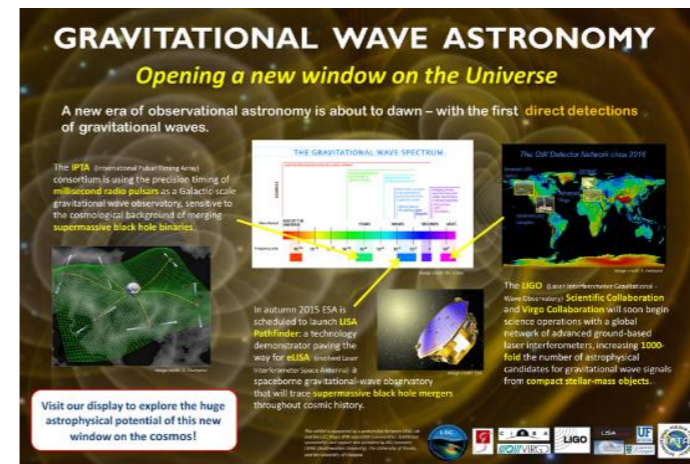
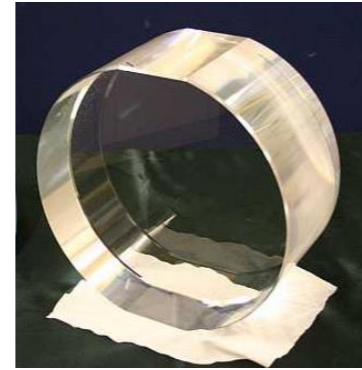
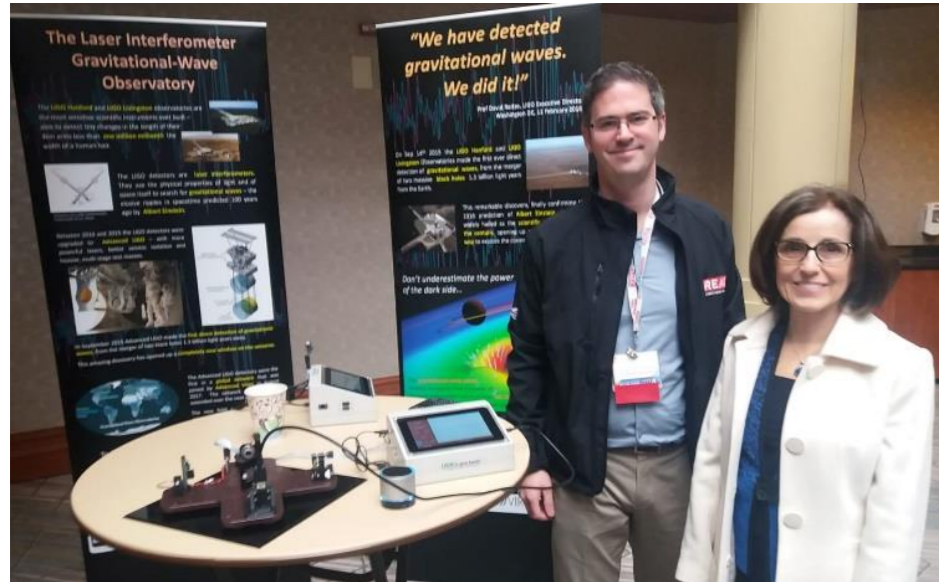


### 2009: \$1M NSF-funded travelling exhibits.

- Featured at WSF, USA SEF, many other US venues
- Not well-suited to “pop up” events: even the small version takes ~3 hours to assemble!...

# Exhibits

Recent focus on greater **flexibility** and **scalability** – creating easily portable exhibit resources to be **used / shared** across collaboration





# Overview of Virgo outreach activities

- About 80 european institutes
- About 400 members

wide range of activities across Europe:

- visits at the Virgo site
- web site
- activities on major social networks
- participation to several events across Europe
- participation to art&science exhibitions
- dedicated initiatives to target some specific public
- comics on GWs

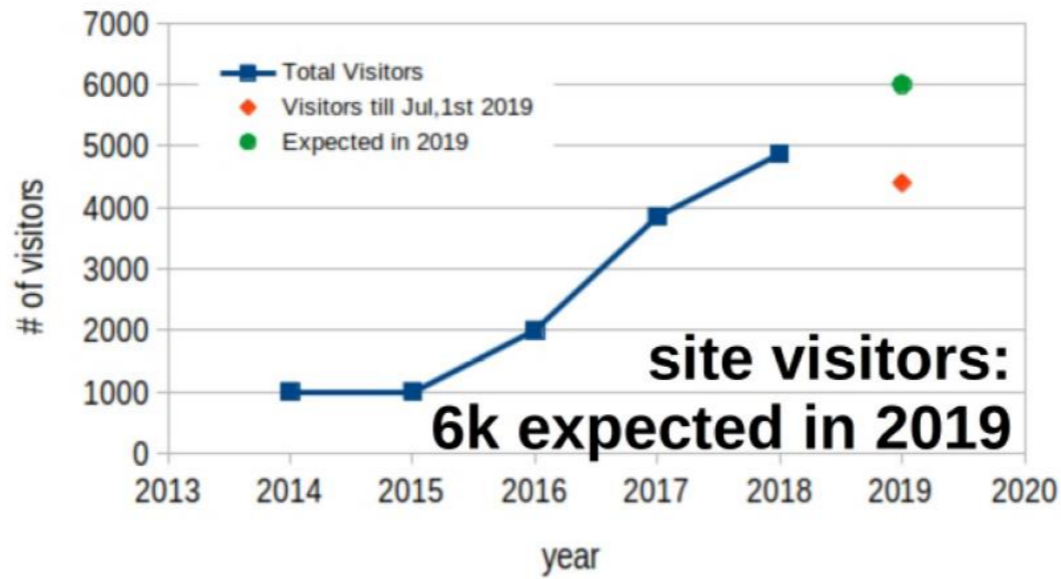
[www.virgo-gw.eu](http://www.virgo-gw.eu)



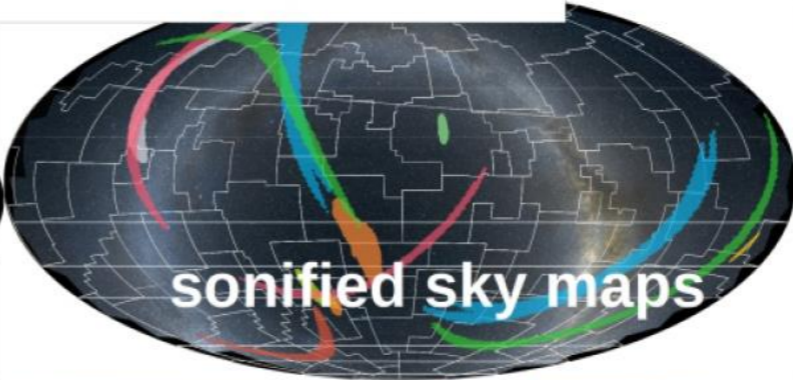
no personnel hired specifically for outreach: only on voluntary basis



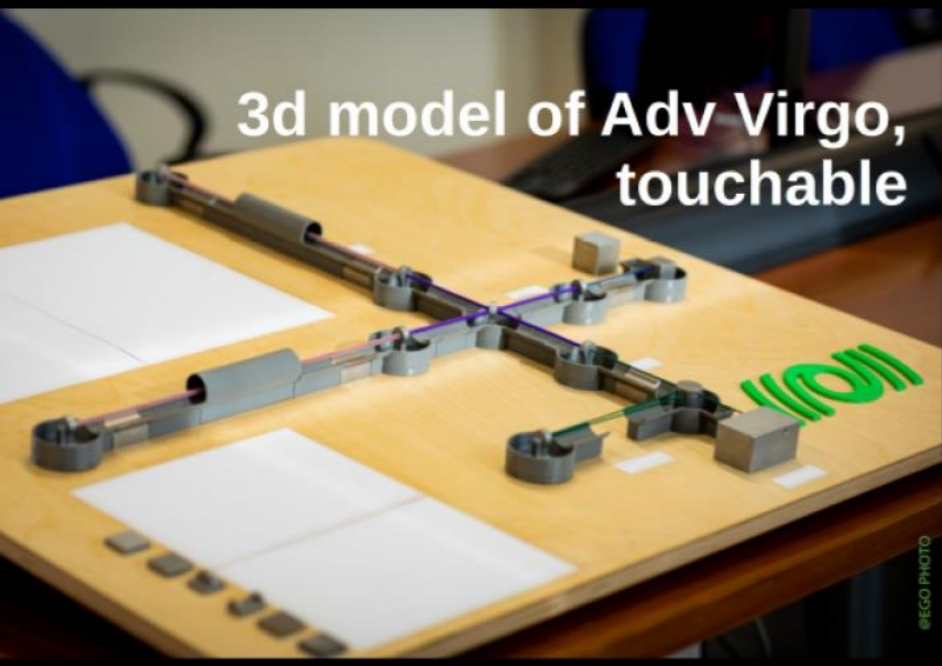
3d printed waveforms



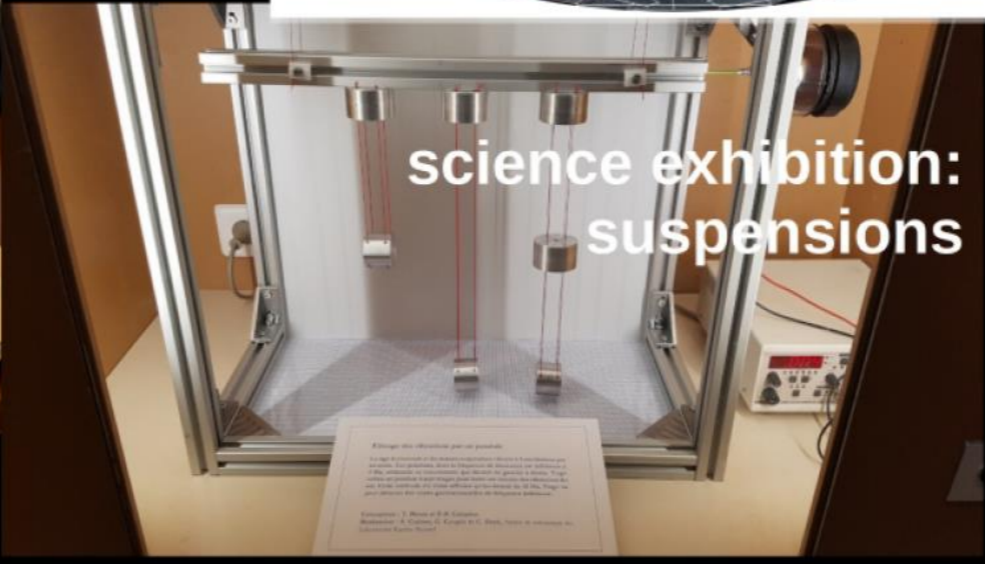
art&science exhibition  
multimessenger room



sonified sky maps



3d model of Adv Virgo,  
touchable



science exhibition:  
suspensions



comics on GWs

Racconti  
dal Bar Ronda  
- LE ONDE GRAVITAZIONALI E VARI CATACLISMI -





LISA MISSION

LISA PATHFINDER

NEW ASTRONOMY

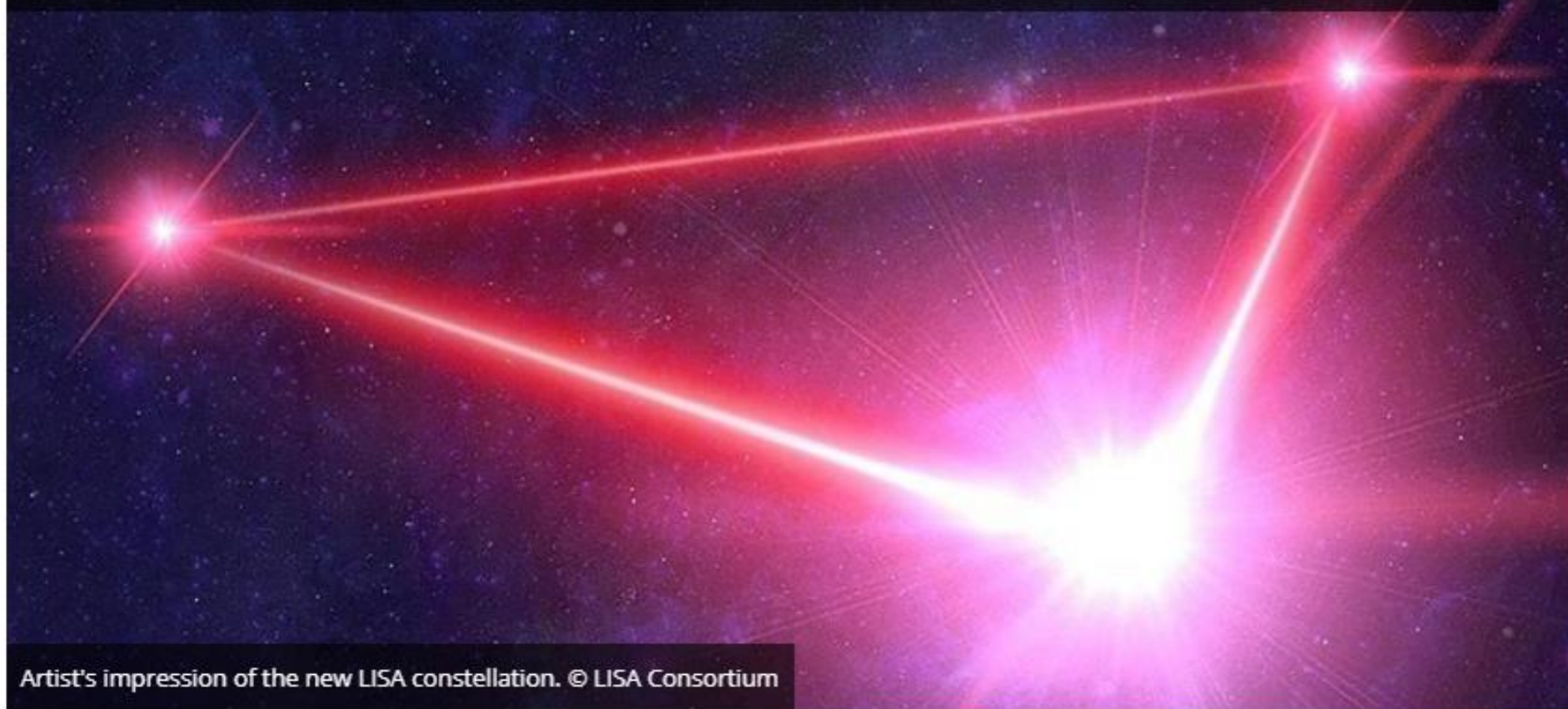
CONTEXT 2030

CONSORTIUM

COMMUNITY

## LISA Consortium reboots to build mission

Call for applications to the renewed LISA Consortium



- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13

tweet | share | share | share | pin it | share

LISA Consortium Internal

Register as scientist

Code of conduct

Newsflash

**LISA Consortium Reboot**  
We are now ready to reboot the Consortium and ask you to apply. You will find all necessary information on the Application Portal here:  
<https://signup.lisamission.org>

Images



# LISA Consortium Advocacy and Outreach Working Group

## Context: a draft “mission statement”

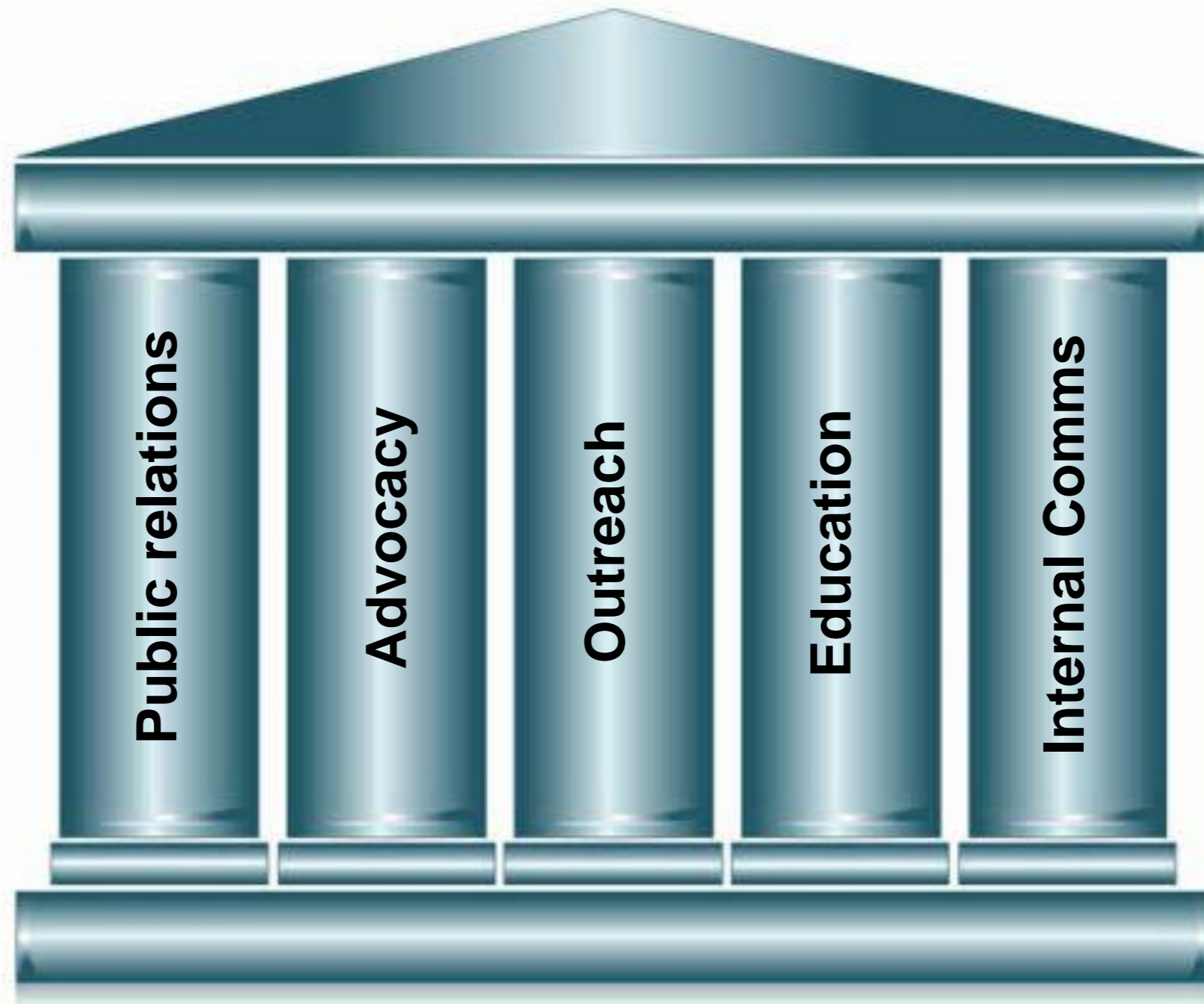
The Advocacy and Outreach (a.k.a. “**AdvoReach**”) Working Group aims to promote, support and coordinate:

1. communication and regular exchange of information between the mission teams and working groups within the Consortium, and with the broader LISA community;
2. coordination, as appropriate, with outreach projects and activities carried out by other Gravitational-Wave communities (e.g. LIGO, Virgo, NANOGrav, etc);
3. outreach to the wider astronomical community - particularly in common science areas, advocating for LISA and emphasising the complementarity of LISA science;
4. promotion and raising awareness of LISA to different non-science audiences – specifically the general public, journalists, politicians and other decision makers – in terms of both the exciting science questions LISA will address and the remarkable technology that will enable this.

**AdvoReach co-chairs:** Martin Hendry (University of Glasgow, UK)

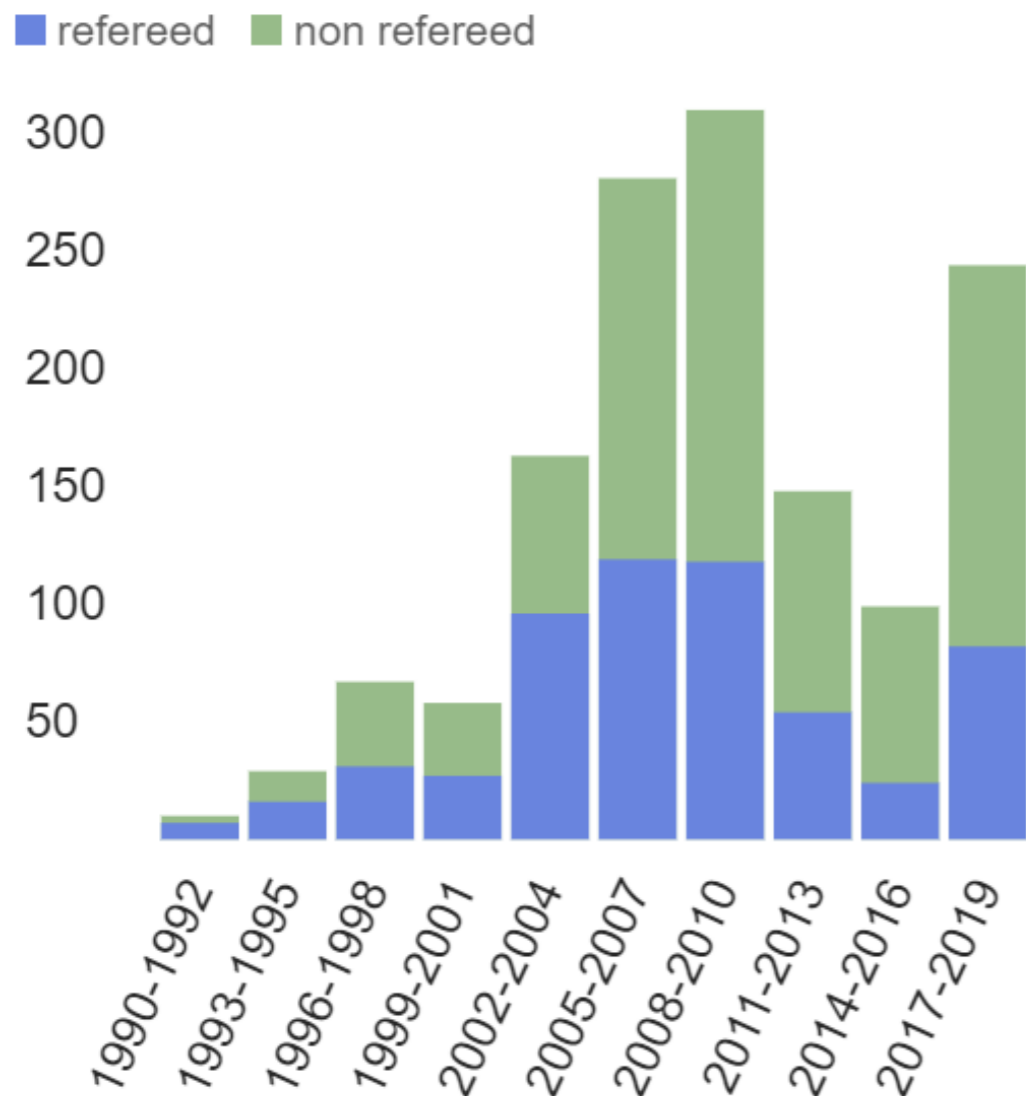
Kelly Holley-Bockelmann (Vanderbilt University, US)

# *Five pillars of LISA AdvoReach*



# “LISA” papers: 1990-2019

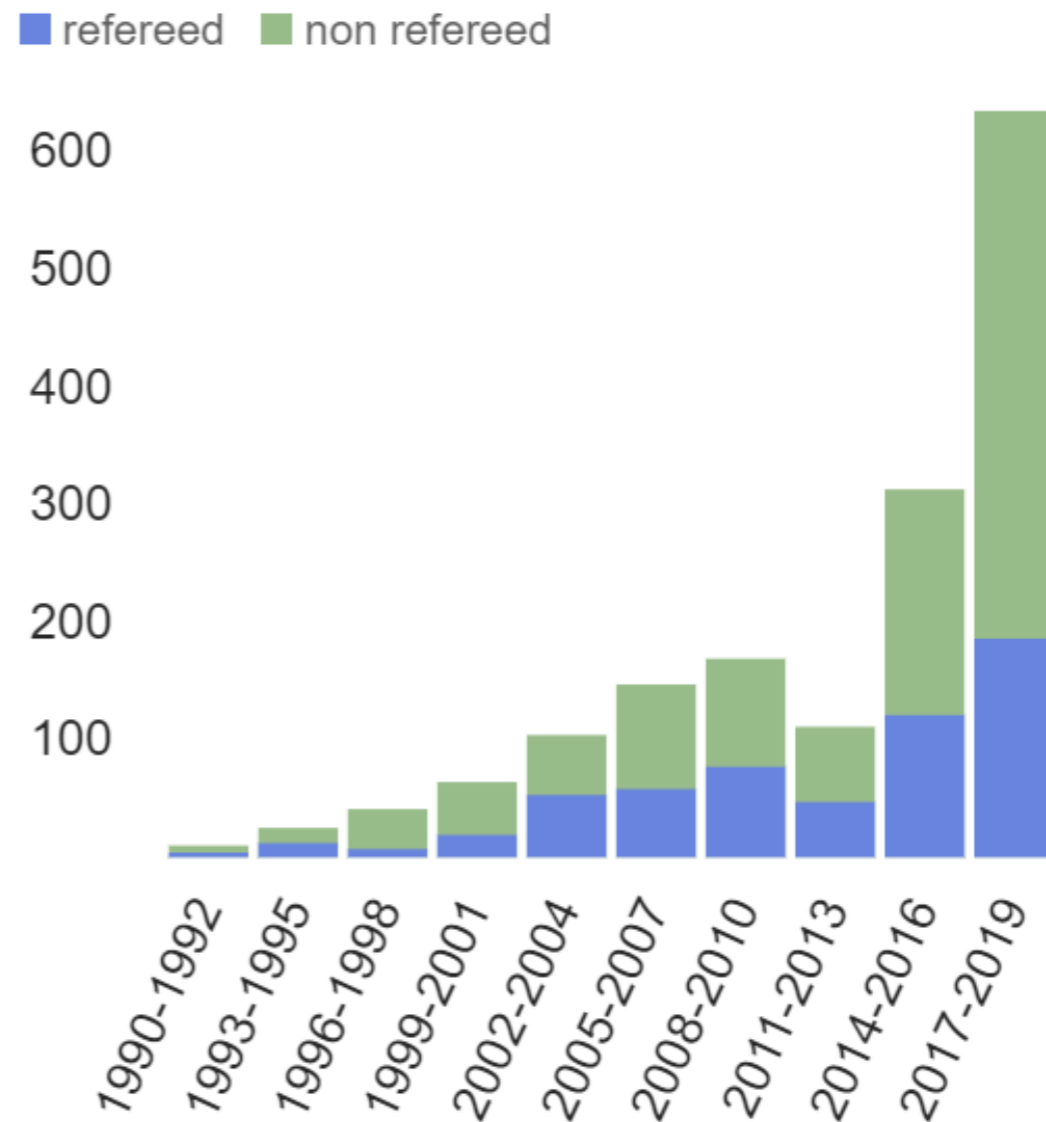
Total number: 1409



total number of citations : 13,543

# “LIGO” papers: 1990-2019

Total number: 1619



total number of citations : 24,022

# lisa pathfinder



ESA

SCIENCE & TECHNOLOGY

LISA PATHFINDER

## Missions

- [Show All Missions](#)

## Mission Home

- [Summary](#)
- [Fact Sheet](#)
- [Objectives](#)

## Participants

- [Mission Team](#)
- [Industrial Team](#)

## Outreach resources

## Background

- [Why LISA Pathfinder?](#)
- [A challenging build](#)
- [What LISA Pathfinder is doing and how](#)
- [Paving the way for gravitational-wave observatories in space](#)
- [100 years of General Relativity](#)
- [LISA Pathfinder in the context of great physics experiments](#)



Search here



9-Jul-2019 06:07 UT

## Shortcut URL

<http://sci.esa.int/jump.cfm?oid=56932>

## OUTREACH RESOURCES

This page collates a number of outreach resources for LISA Pathfinder

### CONTENTS OF THIS PAGE

[Launch-related material](#)

[LISA Pathfinder mission brochure and ESA Bulletin article](#)

[Social media: twitter](#)

[Posters](#)

[ESA image & video archive](#)

[Videos from the LISA community](#)

[ESA Euronews and ESA TV](#)

[Other websites](#)

### LAUNCH-RELATED MATERIAL

[Video footage](#) of launch.

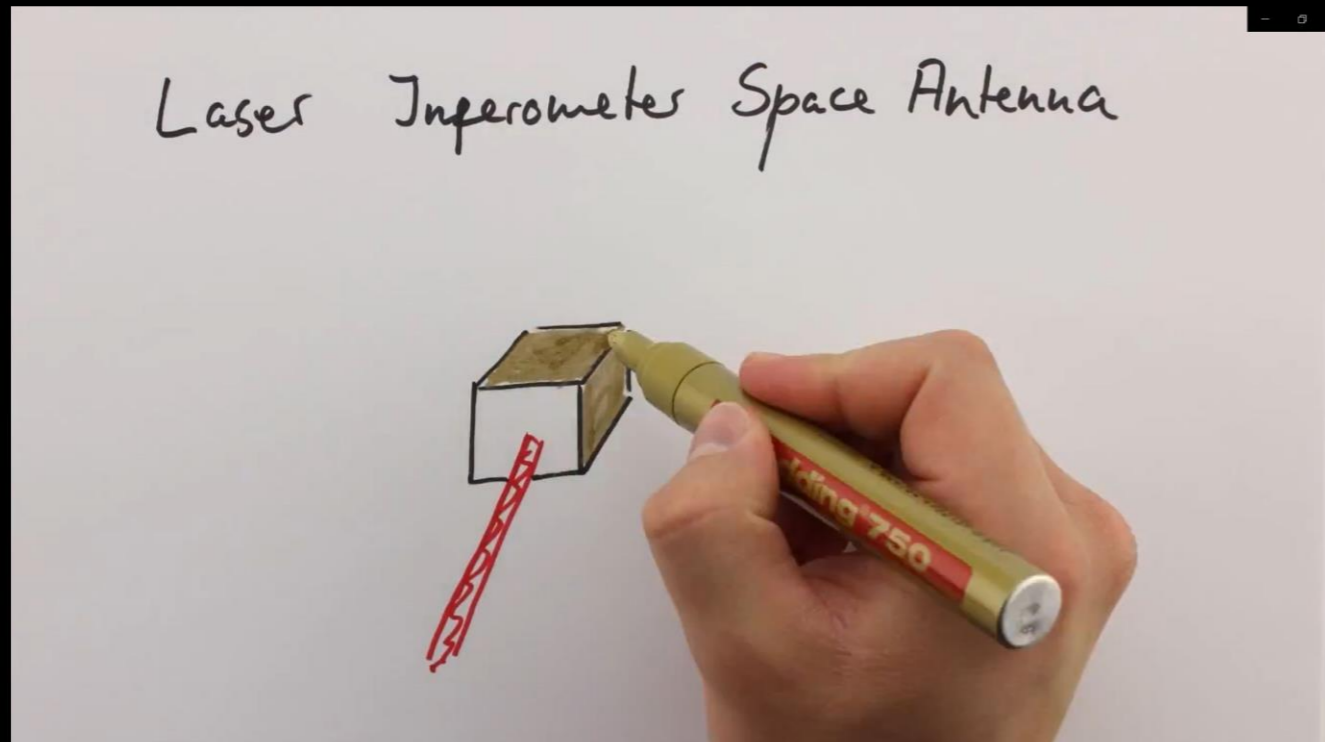
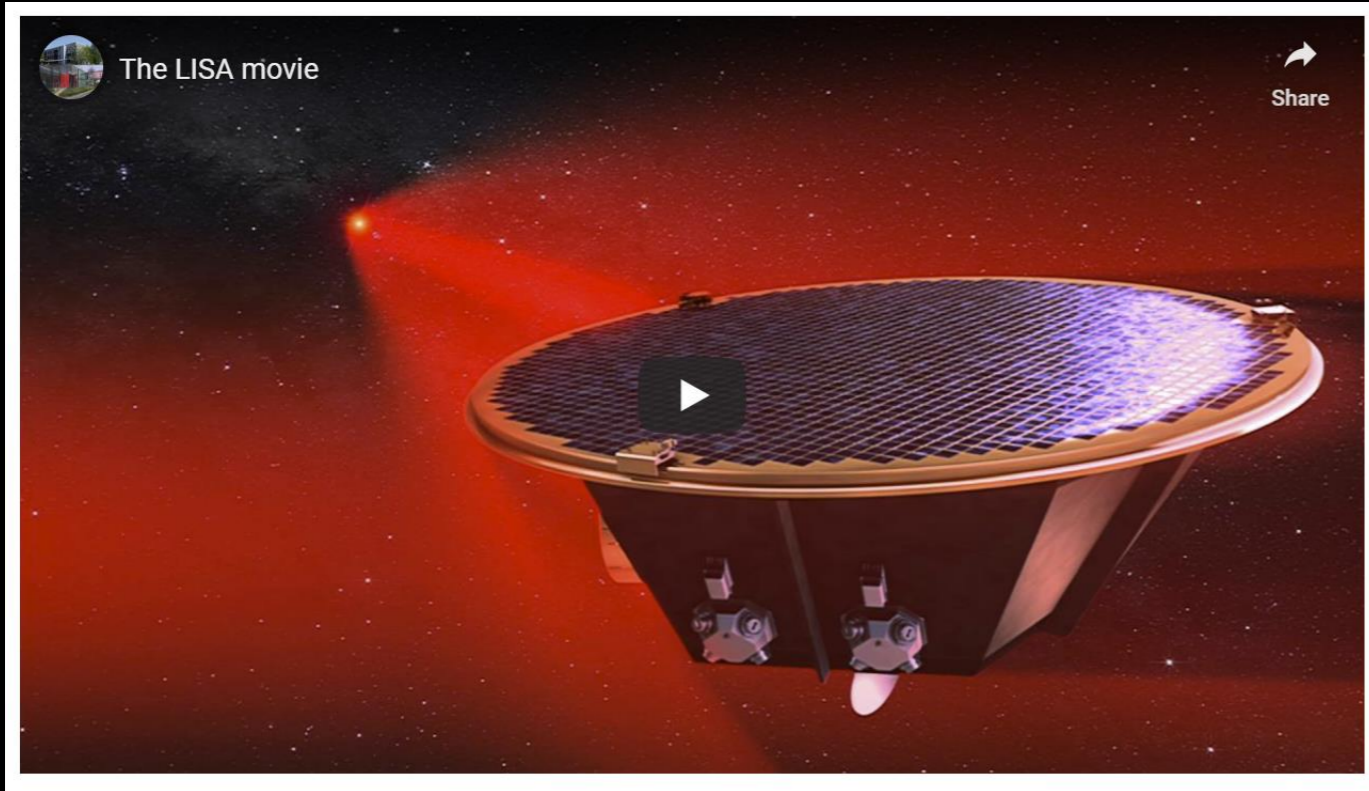
[Launch replay](#) - extended, with commentary.

ESA [media kit](#) for LISA Pathfinder.

Arianespace [press kit](#) for launch.

[Schedule](#) for launch event on 2 December 2015, including details of live streaming.

[Update 2 December](#): The launch of LISA Pathfinder has been postponed to 3 December. Updated [launch schedule](#) and [live streaming details](#).



# LISA

We will observe gravitational waves in space

 Search

- LISA MISSION
- LISA PATHFINDER
- GRAVITATIONAL WAVE ASTRONOMY
- CONTEXT 2030
- CONSORTIUM

Home / Multimedia Video

## Multimedia Video



- Overview
- Images
- Video
- Audio

select filter presets

### Free topics

select filters manually

Videopreview	Title	Media Description	Date
	The path to LISA: a unique collaboration	The LISA Pathfinder mission, which demonstrated key technologies for the LISA...	Jun 05, 2019
	The path to LISA: LISA Pathfinder was a lab in space	LISA Pathfinder, the test mission for LISA, the planned gravitational-wave observatory in...	Feb 22, 2019
	The path to LISA: The interferometers of LISA and LISA Pathfinder	The LISA Pathfinder mission and LISA, the planned gravitational-wave observatory in...	Nov 07, 2018
	The core of LPF and LISA – free falling test masses	At the core of the LISA Pathfinder mission and at the core of LISA, the planned...	Aug 02, 2018

**The Gravitational Wave Astronomical Revolution**

**David Reitze**  
 LIGO Laboratory, California Institute of Technology  
 Physics Department, University of Florida

NSF

UF UNIVERSITY of FLORIDA

Caltech

LIGO VIRGO

0:00 / 1:03:41

Image Credit: Aurore Simonnet/SSU

The Gravitational Wave Astronomical Revolution

1,432 views

42 2 SHARE SAVE

LISA Mission

SUBSCRIBED 8.5K

Live chat replay is not available for this video.

Up next AUTOPLAY

**I Visited the First Gravitational Wave Detector! LIGO | STELLAR**  
 Physics Girl 316K views  
 8:20

**FULL The Rachel Maddow Show 7/8/19 | MSNBC News Today...**  
 Trêntay.com.vn Recommended for you  
 New 43:39

**"terrific guy"**  
 Trêntay.com.vn Recommended for you  
 New 40:36

**The Moment Bill Hader Realized Reality TV was Fake**  
 Jimmy Kimmel Live Recommended for you  
 5:09

**Bill Hader's Most Obscure Impressions**  
 Jimmy Kimmel Live Recommended for you  
 6:28

**The Rachel Maddow Show 7/8/19 | MSNBC News Today...**  
 Trêntay.com.vn Recommended for you  
 New 40:40

**Chernobyl's Radioactive Lava is**



# Activities for educating junior LISA scientists

Fumiko Kawazoe

- 5 lectures on LISA science were offered during the AEI lecture week in 2018
  - Compact binaries, MBH cosmic growth,
  - Probing MBH binaries with LISA and pulsar timing, etc.



- A joint topical workshop is planned by Urbino and AEI Hannover
  - In 2019 in Urbino
  - On Astroparticle physics and GW astronomy



**LISA** We will observe gravitational waves in space

LISA MISSION | LISA PATHFINDER | GRAVITATIONAL WAVE ASTRONOMY | CONTEXT 2030 | CONSORTIUM

Home / Consortium / Join consortium

Consortium Group list | Consortium User Guide Link | Consortium Code of Conduct | Consortium News | **Join the community!**

tweet | share | share | share | pin it | share

➔ The LISA community welcomes all scientists who wish to contribute.

**Consortium membership for scientists**

If you are a scientist and wish to contribute to the LISA mission, use this **scientist registration form**.

• Legal  
• Privacy Policy

Powered by Drupal



[advoreach@lisa mission.org](mailto:advoreach@lisa mission.org)

[advoreach-chairs@lisa mission.org](mailto:advoreach-chairs@lisa mission.org)



**NANOGrav**  
Physics Frontiers Center

**W**  
BOTHELL

# Education And Public Outreach Efforts by Pulsar Timing Array Collaborations

**Jeffrey S Hazboun**

Funded under NSF Award 1430284

Image Credit: Tonia Klein

# EPO Pyramid

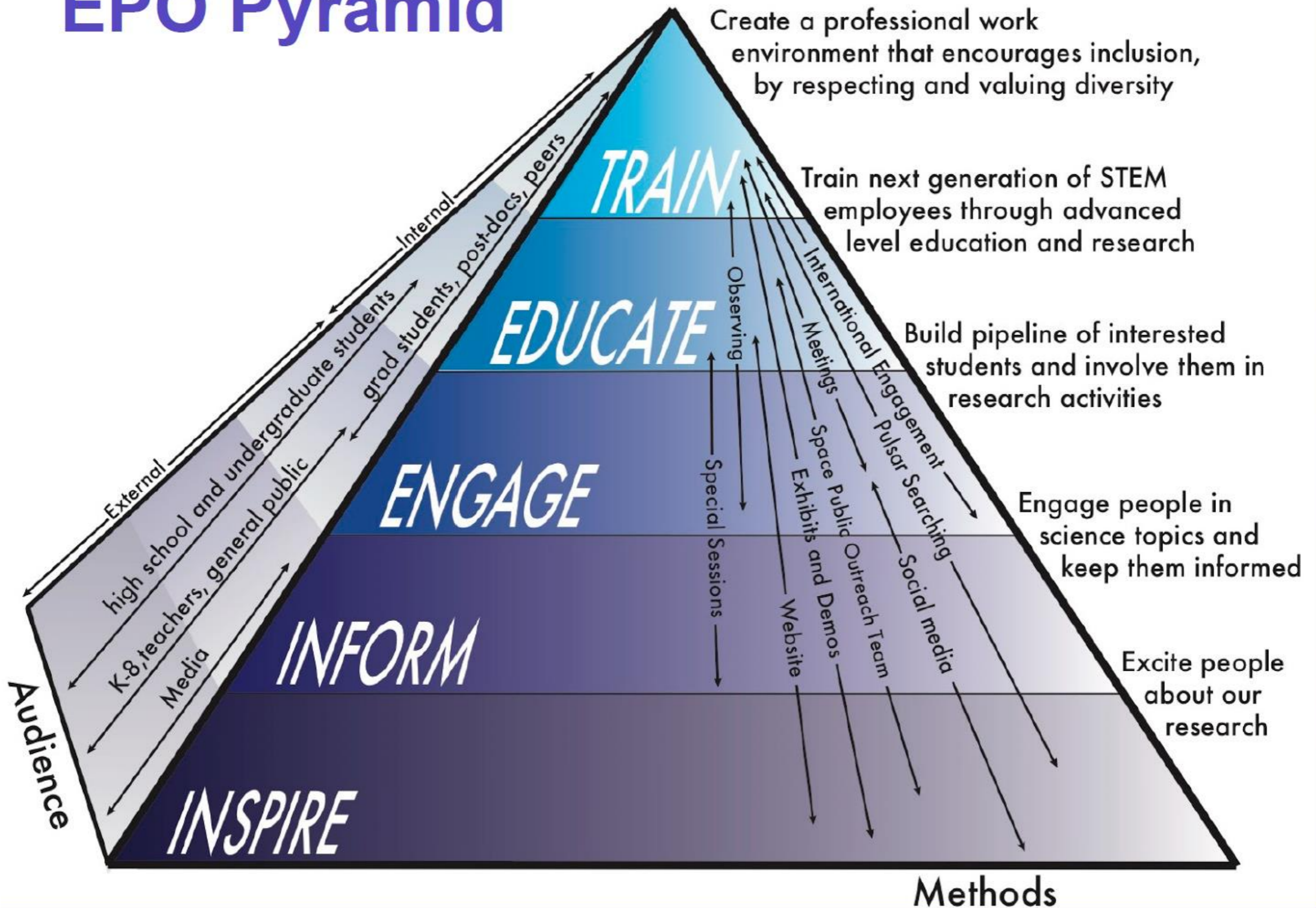


Image Credit: Kristina Islo, Joey Key, Tonia Klein, Joseph Swiggum

# Popular Articles



## ASTRO BEAT



### Catching Gravitational Waves with Radio Pulsars

By Timothy Dolch (Hillsdale College)

May 2018

**In the five decades since Jocelyn Bell-Burnell's discovery of the first pulsating radio star—a pulsar—we now know of at least 2600 such objects in our Galaxy.** Many of these lighthouse-like interstellar beacons are active not only at radio wavelengths, but across the electromagnetic spectrum: for example, the Crab Pulsar emits about thirty flashes per second even in optical light. Short rotational periods, usually on the order of one second or less, constrain these energetic objects to have diameters of about 10 km. The only state of matter known to remain stable under such high centrifugal forces is nuclear matter. In other words, pulsars are enormous, rapidly rotating atomic nuclei! Such an exotic state of matter—known as a neutron star—is consistent with predictions that supernovae should leave compact remnants behind. The Crab pulsar is the Holy Grail of the supernova-neutron star connection; the pulsar sits right in the middle of the Crab Nebula, associated with the Crab Supernova of 1054.

Figure 1: The NRAO Robert C. Byrd Green Bank Telescope in West Virginia (top) and the 305-m William E. Gordon Telescope at Arecibo Observatory in Puerto Rico (bottom). From greenbankobservatory.org


Tim Dolch, Hillsdale College

## Catching Gravitational Waves With A Galaxy-sized Net of Pulsars, -Steve Taylor



frontiers FOR YOUNG MINDS

Articles Participate Specialties About EN



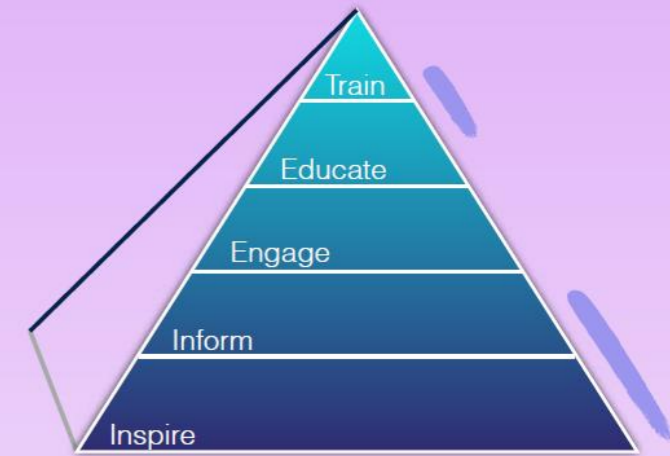
### Science for kids, edited by kids

An open-access scientific journal written by scientists and reviewed by a board of kids and teens.

Learn more

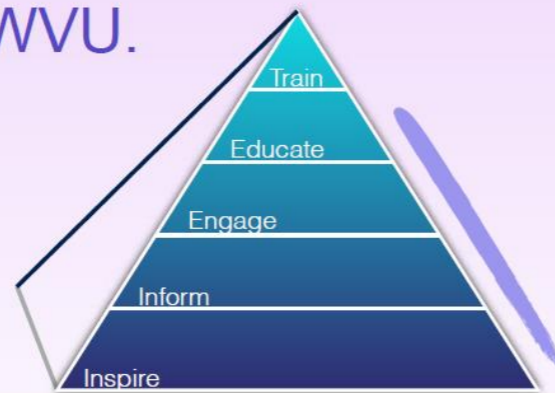
# Space Public Outreach Team (SPOT)

- NANOGrav SPOT Manager: Jessica Page, UAH ([jp0089@uah.edu](mailto:jp0089@uah.edu))
- [#spot](https://nanograv-epo.slack.com) Slack channel for discussion/coordination
- Slides and advertising materials kept up to date on the document database



# Pulsar Search Collaboratory (PSC)

- Currently, 500 high school students, 58 teachers, and 35 undergraduate students from 56 schools across the country.
- PSC mentors training
- Spring online training
- WVU Capstone event
- PSC camp at Green Bank
- PSC 3-credit extension course for high school students offered at WVU.



Co-funded by NSF award numbers 1516512 and 1516269

\*See C8 Tues 1: **The Pulsar Search Collaboratory**, Kathryn Williamson

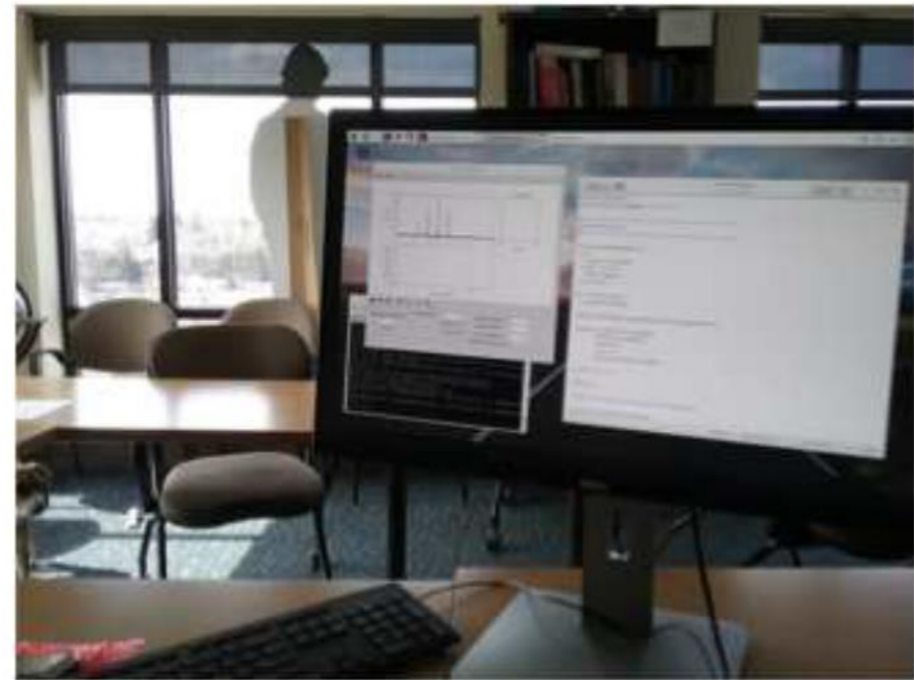
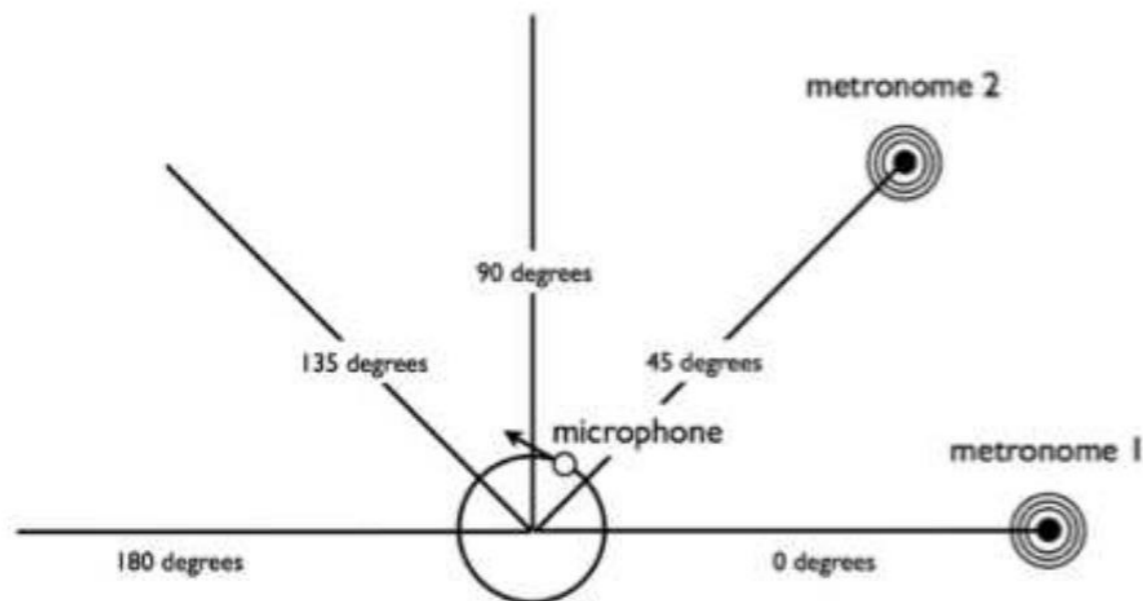
2018 PSC Capstone at WVU



2018 PSC Camp at Green Bank

# Metronome PTA demonstration

## An Acoustical Analogue of a Galactic-scale Gravitational-Wave Detector



Lam, Romano, Key, Normandin and JSH

American Journal of Physics **86**, 755 (2018); [doi.org/10.1119/1.5050190](https://doi.org/10.1119/1.5050190)

[github.com/nanograv/tabletop\\_pta](https://github.com/nanograv/tabletop_pta)





THE UNIVERSITY OF  
WESTERN AUSTRALIA



Australian Research Council  
Centre of Excellence for Gravitational Wave Discovery

# Einstein-First Project

[www.einsteinianphysics.com](http://www.einsteinianphysics.com)

**\$1.5M, 5 year international project aiming to create a complete  
Einsteinian curriculum from Year 3 to Year 12**

## Einsteinian Physics Education Research Collaboration

Australia-Norway-Germany-Scotland- Korea- China-LIGO Scientific  
Collaboration



## Changing Commonsense

**Common sense is the  
collection of prejudices  
acquired by age eighteen.**

Albert Einstein

1948

## Schools Today

Rigid Euclidean space

Time is absolute

Light is a wave  
Bullets are particles

Energy is massless

Newtonian determinism

Gravity: instantaneous  
force

## Modern Understanding

Space flexible and curved

Relative spacetime

Everything combines  
waviness and bulletiness

$$E = mc^2$$

Quantum uncertainty

Gravity: spacetime  
curvature, speed  $c$

Replace implicit or untaught concepts  
with explicit Einsteinian concepts

What is space?

What is time?

What is light?

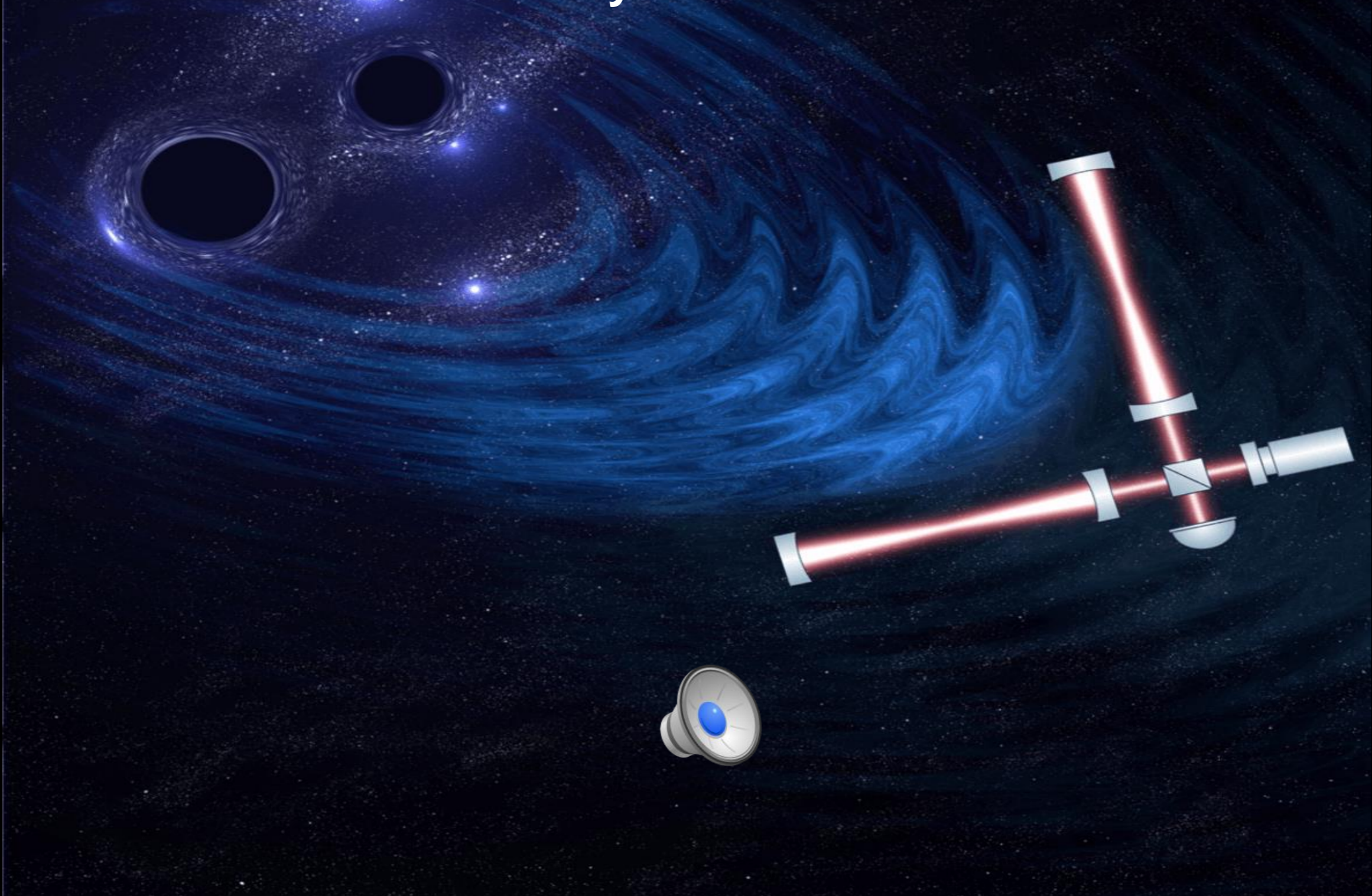
What is gravity?

What is matter?

Even without answers, the key question is *How can you measure it?*

**Gravitational Waves: perfect  
vehicle for Einsteinian Physics**

**The first sounds of  
rippling space**



# Einstein-First Needs People

**Advertising and Appointing Postdocs and PhD students**

**Please spread the word!**

**Talk to David Blair or Ju Li or Magdalena Kersting**

# International Gravitational-Waves Outreach Group



## SATELLITE MEETINGS

1. Spanish-Portuguese Relativity Meeting (EREP2019), July 6, 2019, Valencia (Spain).
2. [International Gravitational Waves Outreach Group Meeting, July 13, 2019, Valencia \(Spain\). Link >](#)
3. Gravity: New perspective from strings and higher dimensions, July 16-24, 2019, Benasque (Spain). [Link >](#)
4. International Congress on Industrial and Applied Mathematics (ICIAM2019), July 15-19, Valencia (Spain). [Link >](#)
5. XXXVII Reunión Bienal de la Real Sociedad Española de Física, July 15-19, Zaragoza (Spain). [Link >](#)