



LISA Consortium
Advocacy and Outreach:
Overview and current status

Martin Hendry,
University of Glasgow, UK

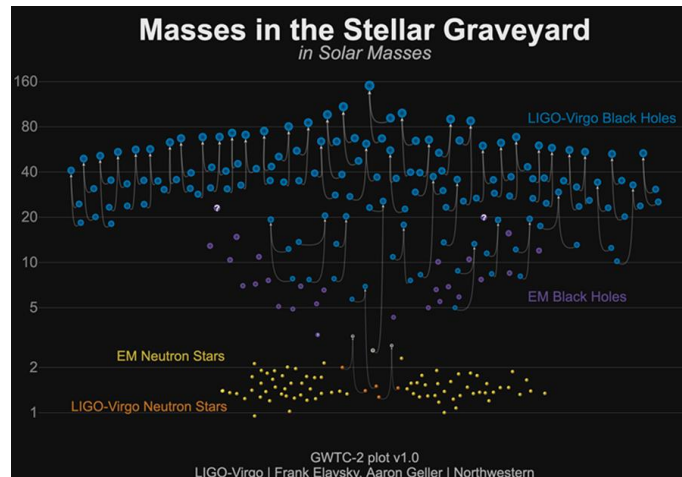
On behalf of the AdvoReach group



Who am I?...

@martin_astro

**Professor of Gravitational Astrophysics and Cosmology
University of Glasgow
Chair, LSC Communications and Education Division**



LISA Consortium Advocacy & Outreach Committee



Kelly Holley-Bockelmann
Vanderbilt Univ.



Martin Hendry
Univ of Glasgow

Our Mission Statement

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

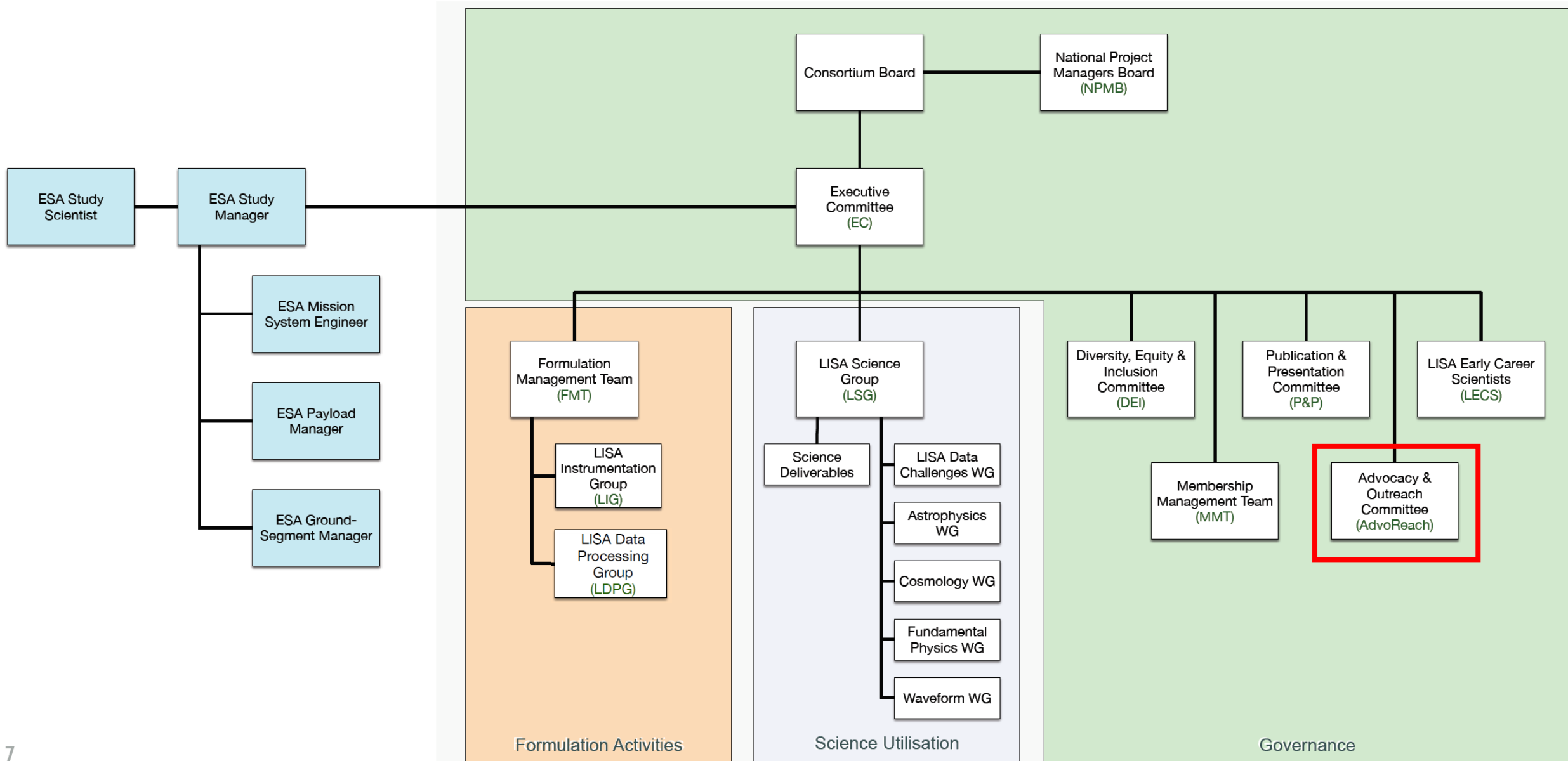
1. communication and regular exchange of information between the mission teams and working groups within the Consortium, and with the broader LISA community;
2. coordination, as appropriate, with outreach projects and activities carried out by other Gravitational-Wave communities (e.g. LIGO, Virgo, NANOGrav, 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.

Contact us:

advoreach@lisamission.org

advoreach-chairs@lisamission.org

LISA Consortium Advocacy & Outreach Committee



LISA Consortium Advocacy & Outreach Committee



Kelly Holley-Bockelmann
Vanderbilt Univ.



Martin Hendry
Univ of Glasgow

In today's session I'll try to cover:

- What is AdvoReach and why get involved?
- Our LISA communications strategy
- Consortium telecons and meetings
- Our website, multimedia and social media
- AdvoReach across the GW spectrum and beyond
- Our work packages and next steps

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advoreach@lisamission.org

advoreach-chairs@lisamission.org

Communications

(with thanks to Susanne Milde)

Successful communications requires a strategy:

- Tailored to the needs of different parties & stakeholders
(e.g. local, regional, national, European, US)
- Coordinated, reviewed with LISA leadership team, regularly updated. **Implemented by AdvoReach Committee**

Key messages / focus topics:

- What is LISA and why is it important?
- LISA science & technology highlights
- Mission status and timeline
- LISA Consortium organisation



[LISA MISSION](#)[LISA PATHFINDER](#)[GRAVITATIONAL WAVE
ASTRONOMY](#)[CONTEXT 2030](#)[CONSORTIUM](#)

LISA Pathfinder - A Space Saga

Relive the groundbreaking technology demonstrator's mission milestones 5 years ago in a new Youtube mini-series released by the LISA Consortium.



1 2 3 4 5 6

[tweet](#)[share](#)[share](#)[share](#)[pin it](#)[share](#)

LISA Consortium Internal

[Register as scientist](#)[Code of conduct](#)

Newsflash

Join the LISA Consortium

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

Images



Communications: major recent / current projects

- Updating our Communications strategy
- Improving our Consortium communications
- Developing a new LISA Consortium website
- Designing a LISA Consortium Logo
- Updating and curating our multi-media resources
- Improving our social media activities
- Coordinating our outreach with other GW / Astro communities

***If you would like to work with us on LISA Comms,
please get in touch: advoreach-chairs@lisamission.org***

Internal Communications: Consortium Telecon

*Last Monday of the month
at 1700 CET/CEST (1500 UTC)*

Programme and calendar at
<https://lisacalendar.darkcosmos.org/>

Agenda:

- Consortium updates
- Space Agency news
- Upcoming meetings, conferences etc
- Special topic:
 - drawn from across all aspects of LISA science, technology (rotates around the WGs)
 - usually 15 – 20 minutes, lots of time for Q&A
 - can showcase recent WG activities or projects, highlight new results or present aspects of WG organisation (e.g. White Papers)



Consortium Monthly Telecon



Agenda

:00' – Welcome

:05' – Consortium News

:20' – Space Agency News

:30' – LISA WG Presentation. This week: The DEI Working Group

If you would like to help us with organizing the Monday Consortium telecons, get in touch with us at:

advoreach-chairs@lisamission.org

Internal Communications: Community Telecon

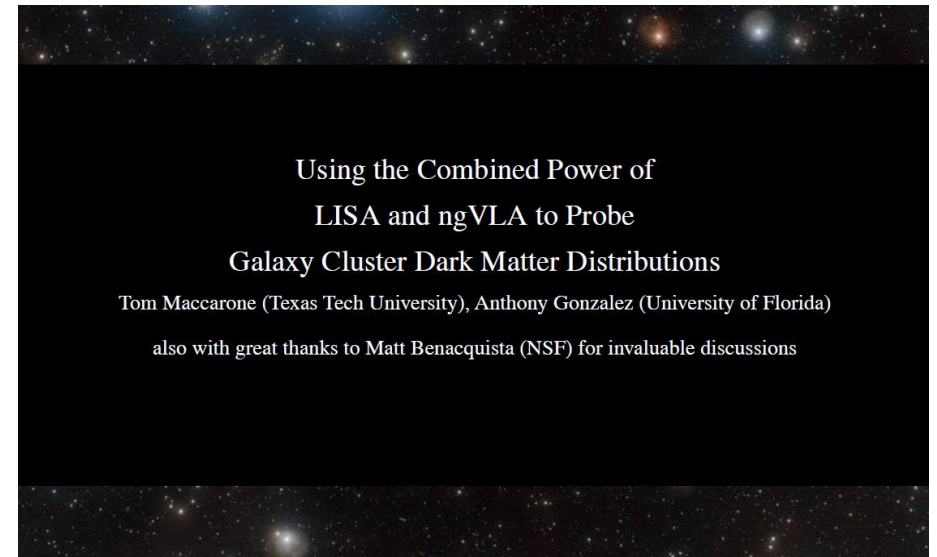
Other Mondays at 1700 CET/CEST (1500 UTC)

These calls are open to anyone – all welcome!

Agenda:

- Summary of main (shareable) Consortium news
- Special topic:
 - drawn from across all aspects of LISA science, technology
 - Again 15 – 20 minutes, lots of time for discussion
 - **Talks designed to introduce LISA science and technology** (and ideally to encourage Consortium membership!...)

Programme and calendar at
<https://lisacalendar.darkcosmos.org/>



If you would like to offer a **special topic talk**, we are always keen to hear from volunteer speakers. Drop us an email at:

advoreach-chairs@lisa-mission.org

LISA Consortium Website: lisamission.org, relaunching soon

Welcome to LISA | Lisamission.org

lisamission.org

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LISA We will observe gravitational waves in space

Search

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

The Gravitational Universe

Illuminating the dark universe with a new astronomy

Artist's impression of supermassive black hole. Credit: ESA/NASA, AVO project, Paolo Padovani.

1 2 3 4 5 6

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

Against racism and discrimination

LISA Consortium Internal

Register as scientist

Code of conduct

Newsflash

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

Images

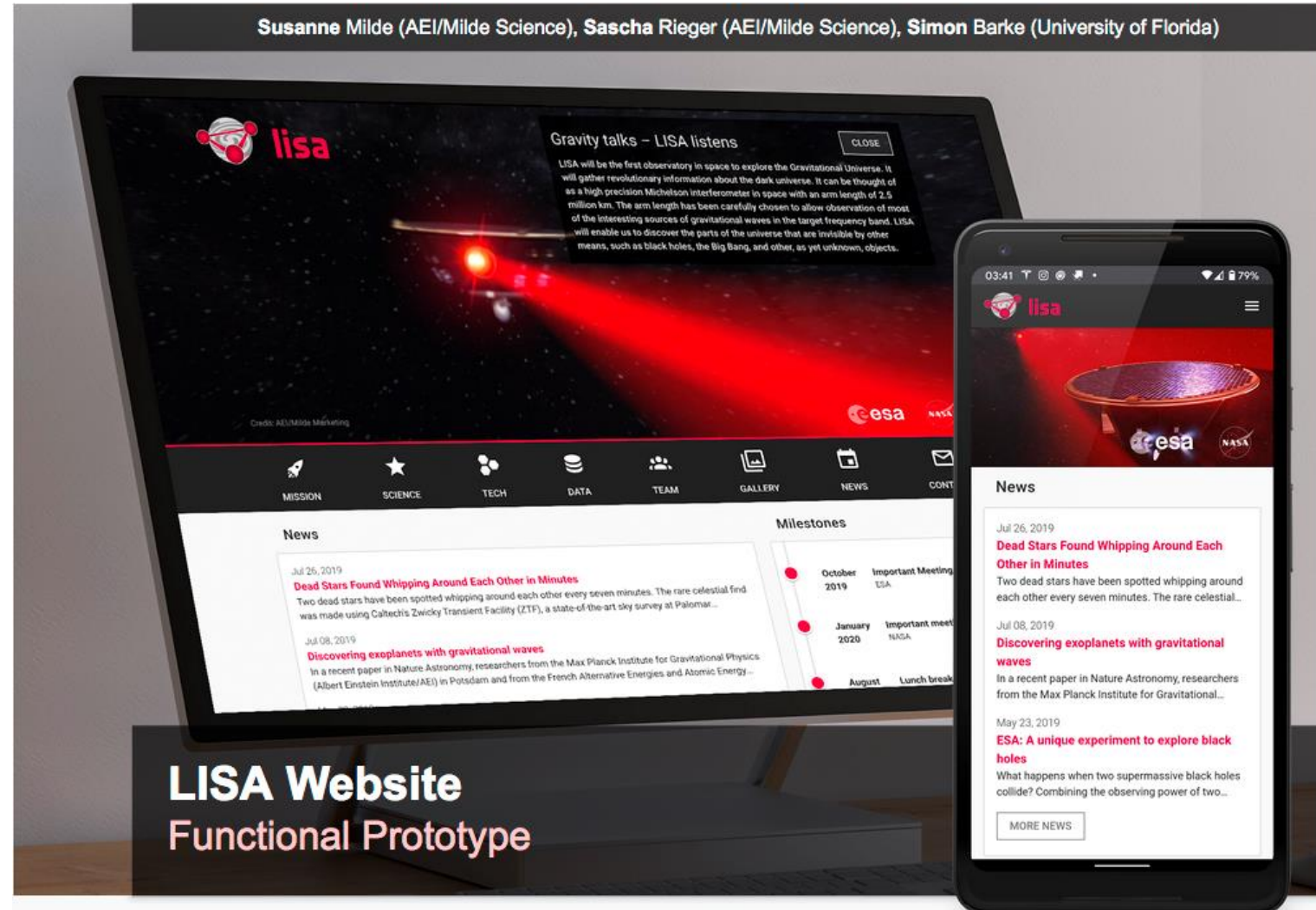
LISA
the first gravitational wave observatory in space

LISA Consortium Website: lisamission.org, relaunching soon

First goal of the relaunch:
modernise the design



2 functional prototypes:
1 clear winner of the Consortium vote



(with thanks to Sascha Rieger and Simon Barke)

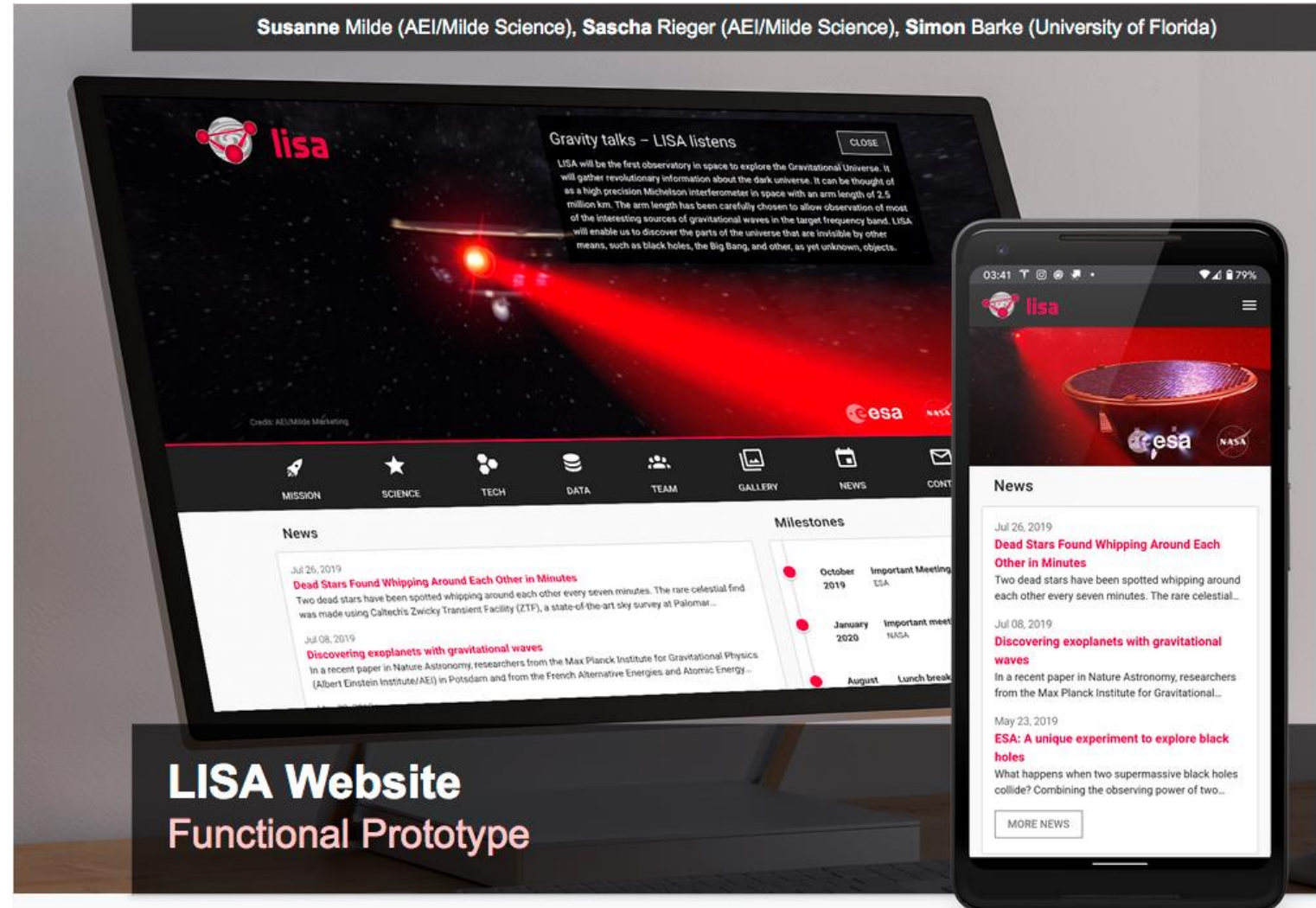
LISA Consortium Website: lisamission.org, relaunching soon

Second goal of the relaunch:
revamp the content

Work in progress

Now collecting input from WGs
as basis for writing **new text**

*Very short overview of each topic,
followed by a subpage of more in-
depth information.*



(with thanks to Sascha Rieger and Simon Barke)

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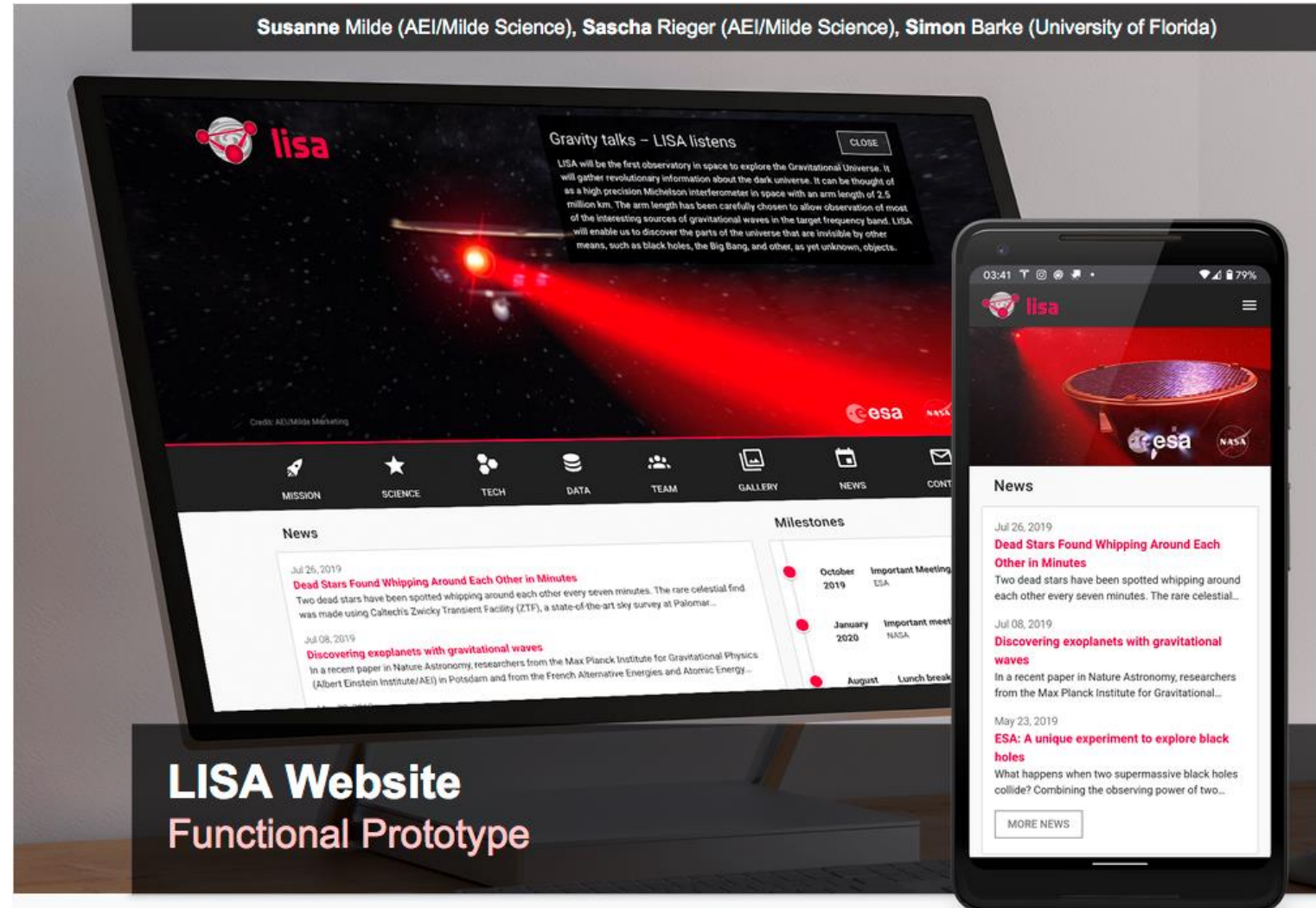
Work in progress

Now collecting input from WGs
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*Very short overview of each topic,
followed by a subpage of more in-
depth information.*

We want to form a **website
editorial team with volunteers**
from all areas of LISA work.

**If you'd like to be a website
editor, drop us an email to
advoreach-chairs@lisamission.org**

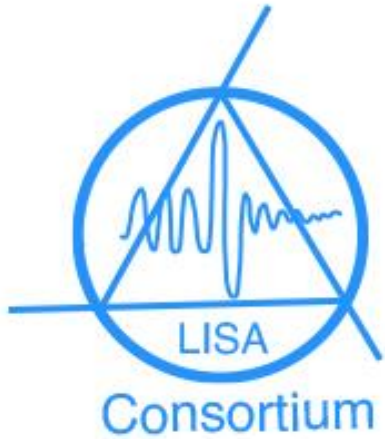


(with thanks to Sascha Rieger and Simon Barke)

Consortium logo competition:

- We received **more than 80** entries!!

(here are some examples...)



LISA  Consortium



From our announcement / call for entries...

Any LISA Consortium logo should ...

- be clear that it is a consortium logo
- not look like an ESA/NASA mission logo (but can use satellites & lasers)
- work on both dark and light backgrounds

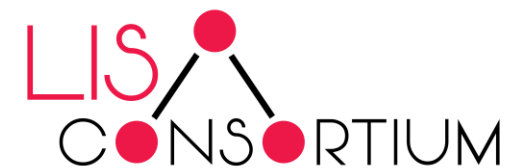
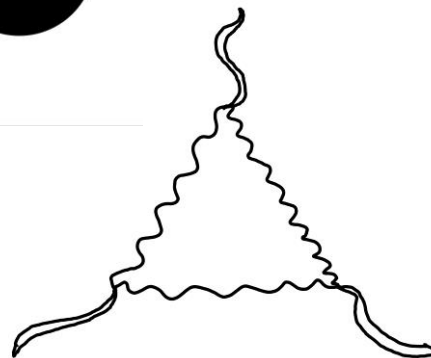
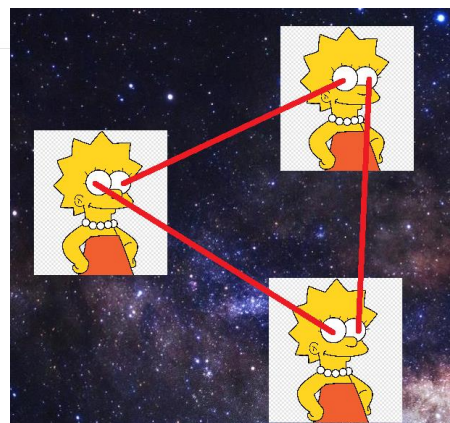
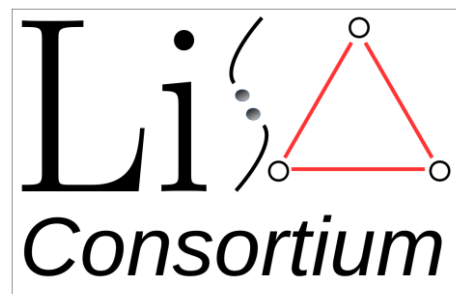
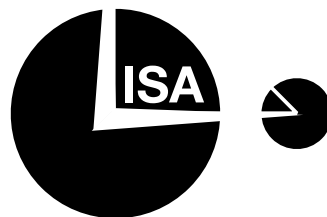
Everything else is up to you!

(with thanks to Sascha Rieger)

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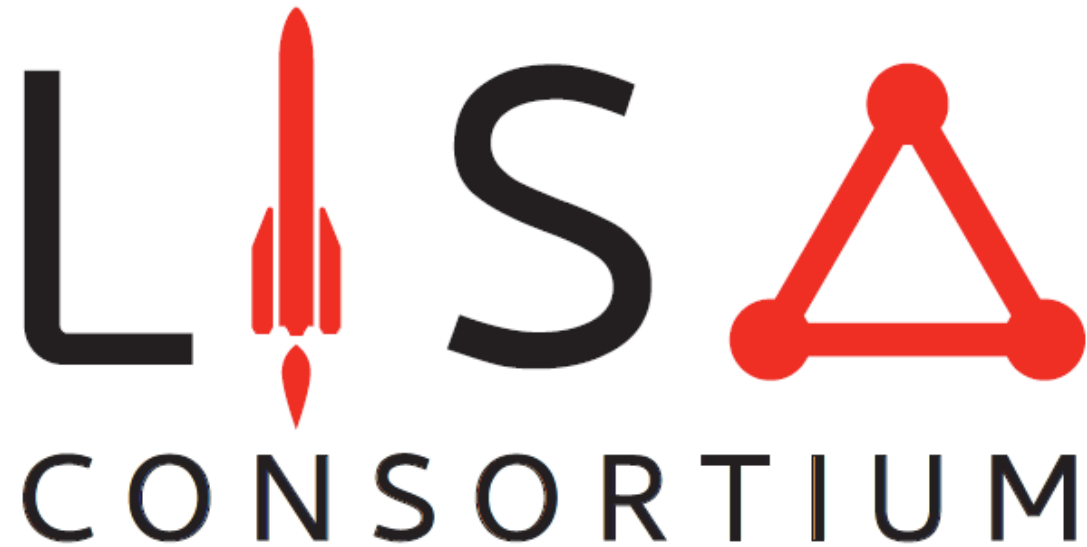
Any LISA Consortium logo should ...

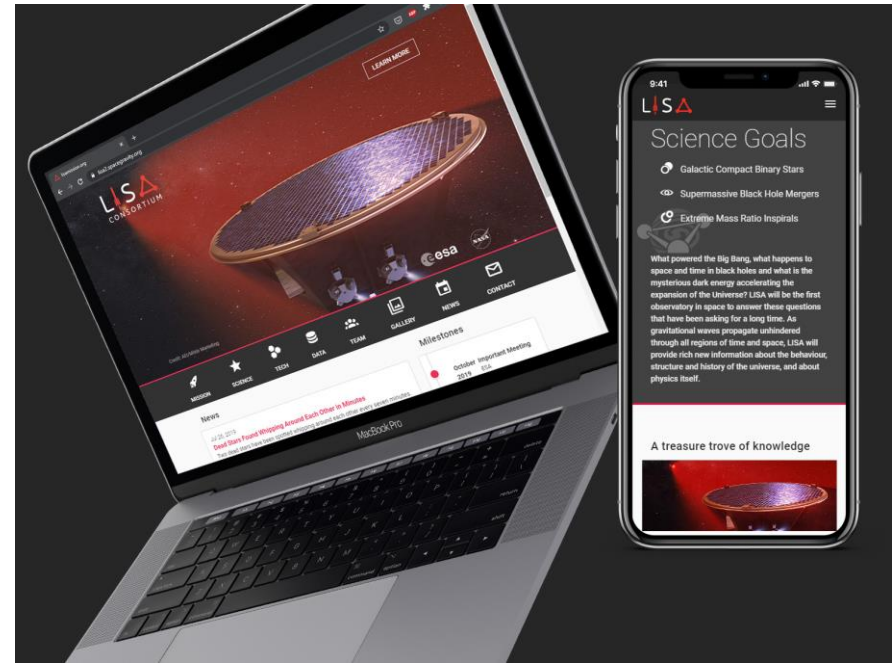
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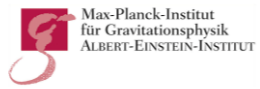
**Congratulations to Davide Dal Bosco
(Trento) for the winning design!**







LISA CONSORTIUM



UNIVERSITÀ DI TRENTO

RIT



UNIVERSITY OF MARYLAND



Berkeley UNIVERSITY OF CALIFORNIA



Netherlands Institute for Space Research



LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE



The University of Sheffield.

COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK



UNIVERSITY OF MINNESOTA



UNIVERSITY OF BIRMINGHAM



Universität Hamburg DER FORSCHUNG | DER LEHRE | DER BILDUNG



Astronomical Institute of the Czech Academy of Sciences



Institute of Physics of the Czech Academy of Sciences

BYU



1506 UNIVERSITÀ DEGLI STUDI DI URBINO CARLO BO



Northwestern Caltech

Imperial College London



TEXAS TECH UNIVERSITY.

UF UNIVERSITY OF FLORIDA

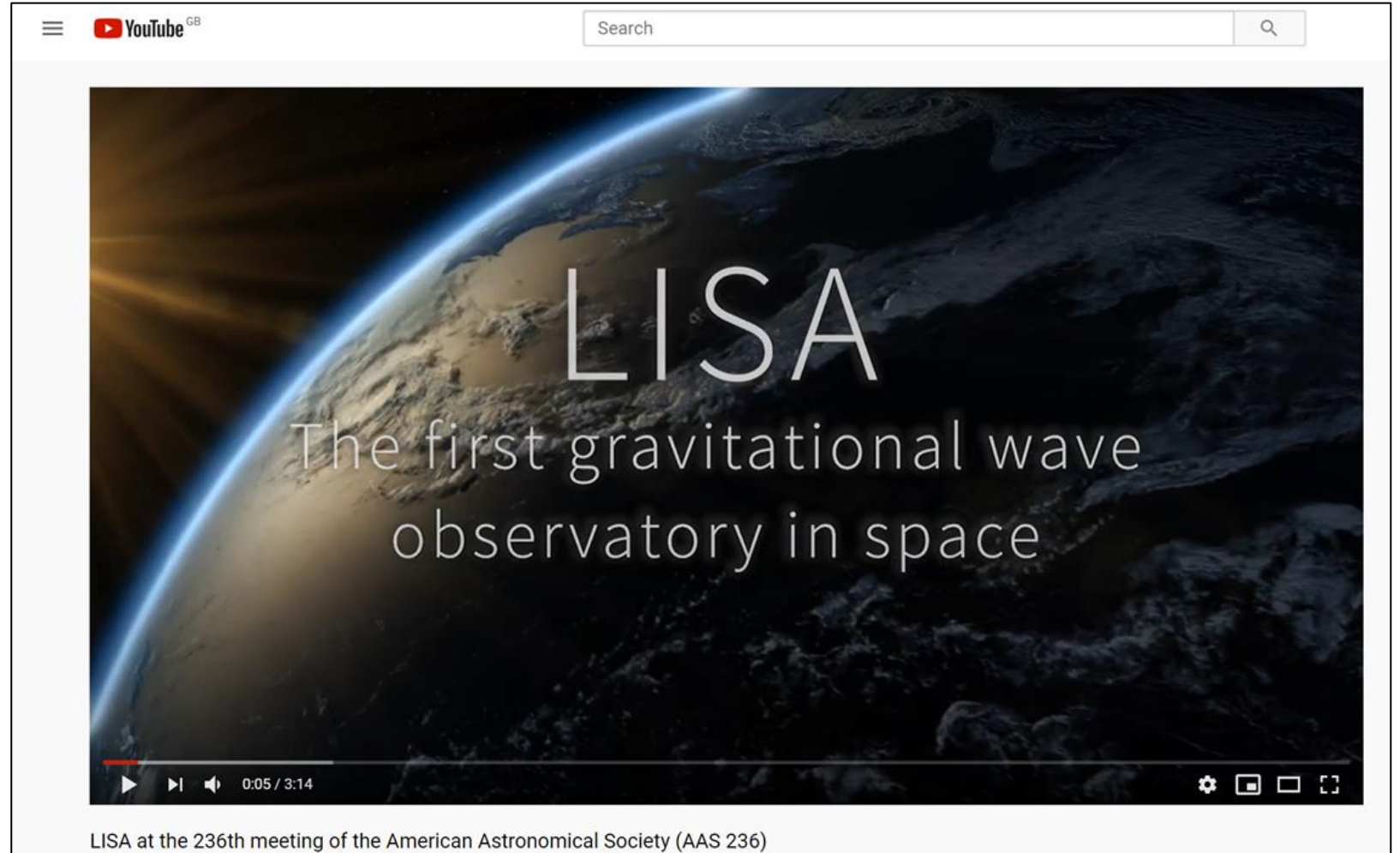
UNIVERSITY OF Southampton



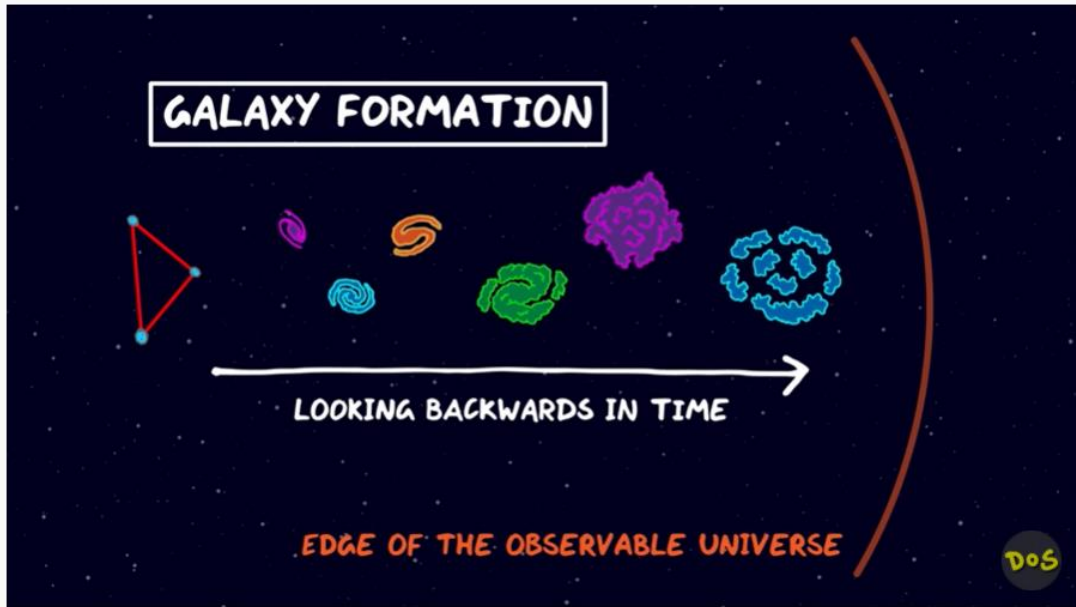
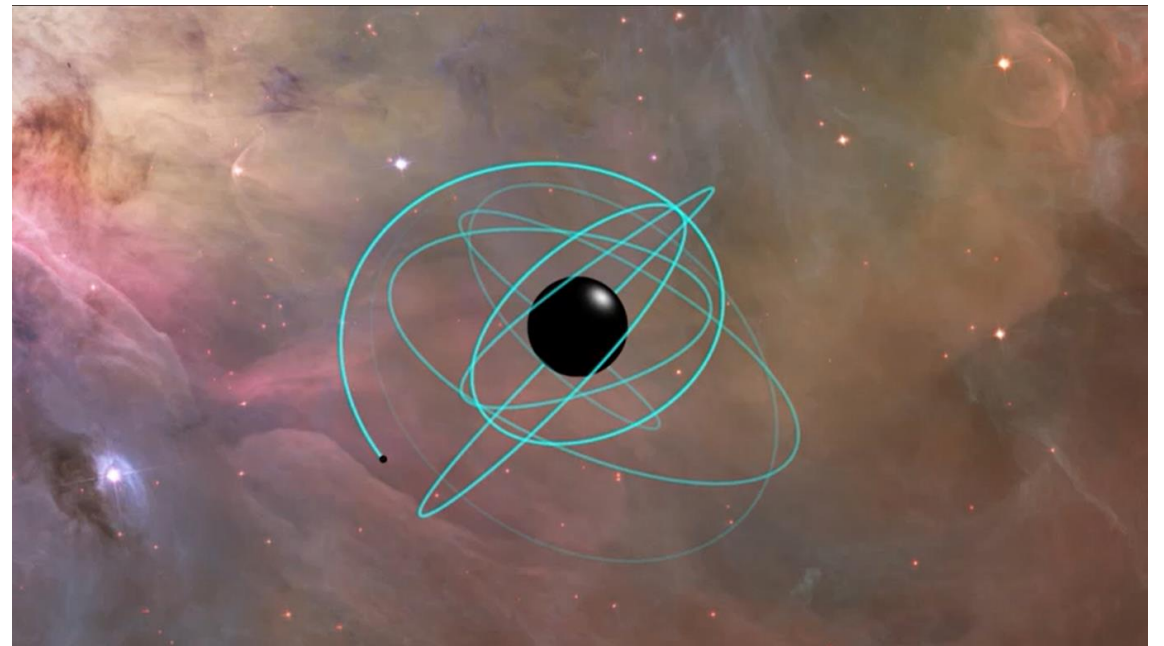
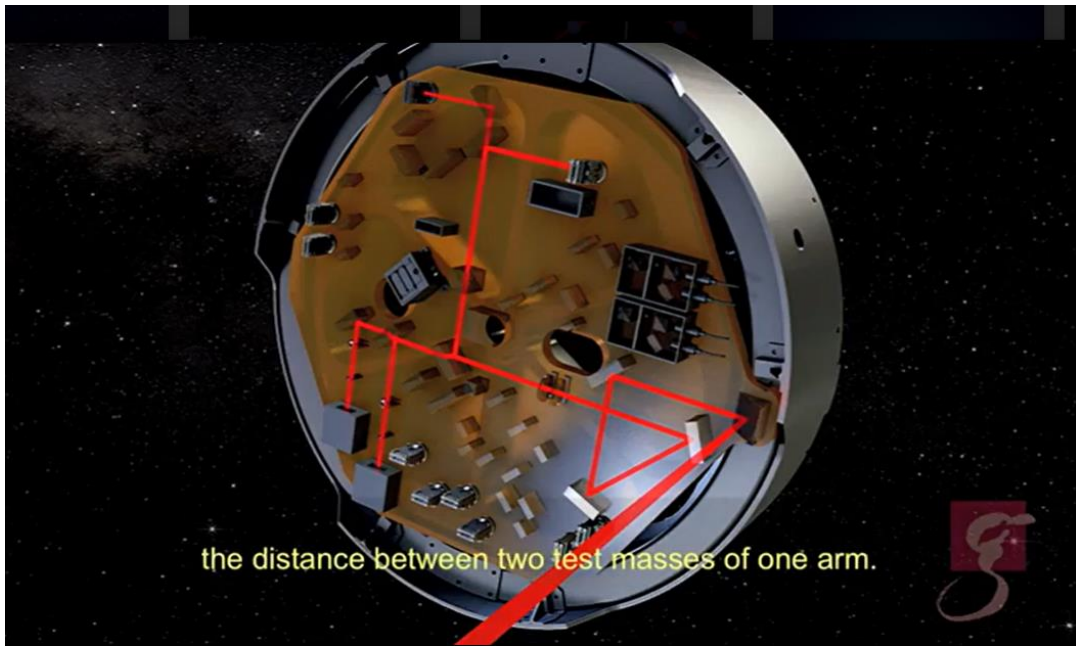
THE UNIVERSITY OF CHICAGO

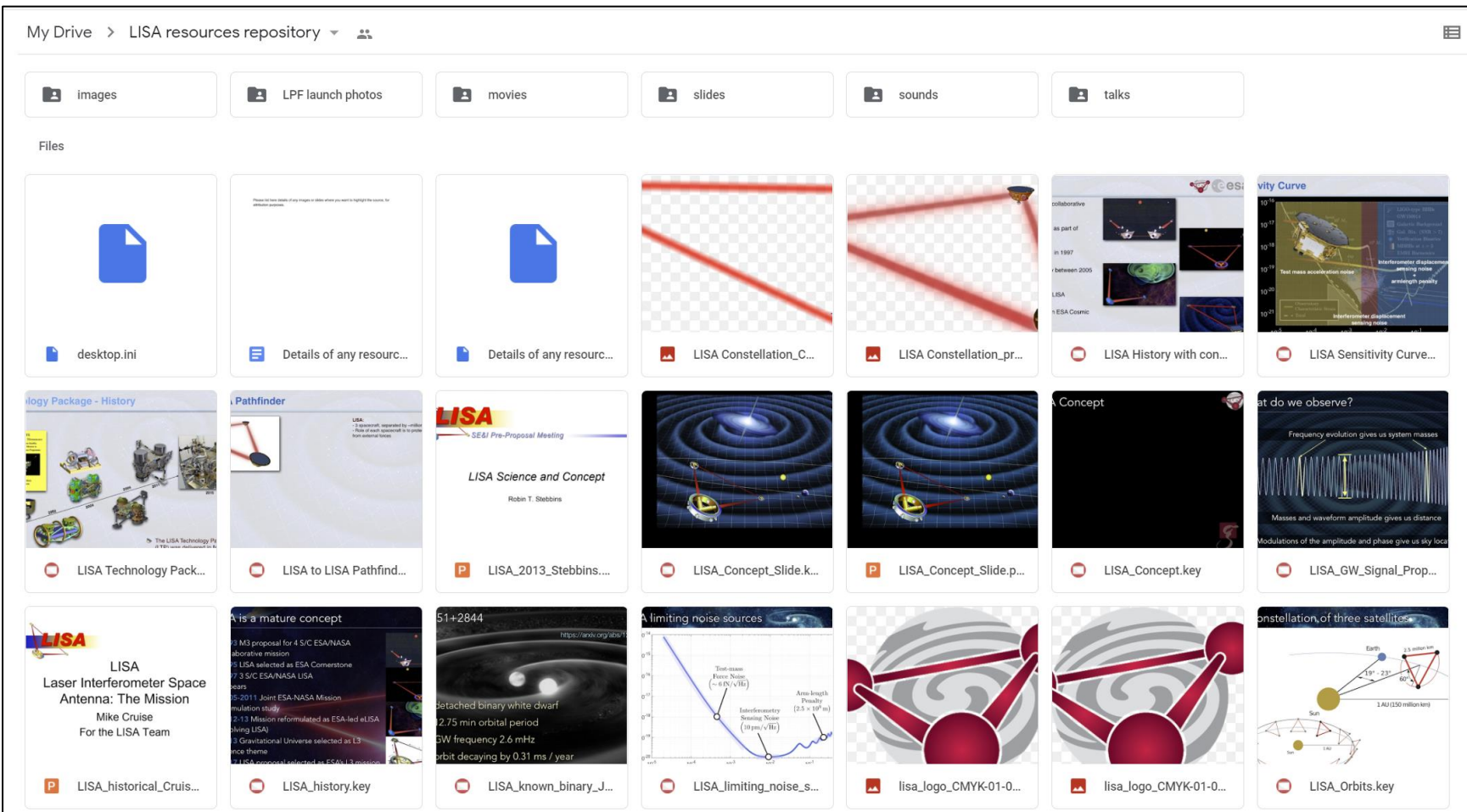
Updated **LISA video** created for AAS 236

- watch it on YouTube at https://youtu.be/h_ApNry_jN0
- A series of shorter clips created from video (useful for seminars, outreach etc)



You can find these at: <https://tinyurl.com/LISA-resources>






KEY TASK:
LOOK THROUGH THE DRIVE (and tell us what is missing, remove duplicates, etc...)

You can find these at: <https://tinyurl.com/LISA-resources>

LISA Multimedia and Social Media

Visit the LISA Mission You Tube channel:

<https://www.youtube.com/user/LISAcommunity>



LISA Mission
8.16K subscribers

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LISA MISSION UPDATE: THE FUTURE OF GRAVITATIONAL WAVE ASTRONOMY
Dec 3, 2020 3pm ET 1:04:45

LISA Mission Update: The Future of Gravitational Wave Astronomy
Deep Astronomy 2.3K views · Streamed 4 months ago
Have you been wondering, as I have, what the latest news is on the amazing space telescope known as LISA? Well wonder no longer as members of the Laser Interferometer Space Antenna (LISA)...

LPF - A Space Saga ▶ PLAY ALL

- LPF - A Space Saga Part 1
LISA Mission
129 views · 3 months ago
- LPF - A Space Saga Part 2
LISA Mission
104 views · 3 months ago
- LPF - A Space Saga Part 3
LISA Mission
156 views · 2 months ago
- LPF - A Space Saga Part 4
LISA Mission
67 views · 1 month ago
- LPF - A Space Saga Part 5
LISA Mission
44 views · 2 weeks ago



LISA Mission
1,156 Tweets

LISA Mission
@LISACommunity Follows you

Gravitational-wave detection from space. Three spacecraft, separated by million kilometers - the largest laser interferometer ever constructed.

lisamission.org Joined March 2013



62 Following 11.4K Followers

Followed by LIGO_TheDocumentary, Les Guthman, and 136 others you follow

Tweets Tweets & replies Media Likes

Follow us at [@LISACommunity](https://twitter.com/LISACommunity)

Listen to the Universe.

lisamission.org  



LISA Mission

8.16K subscribers

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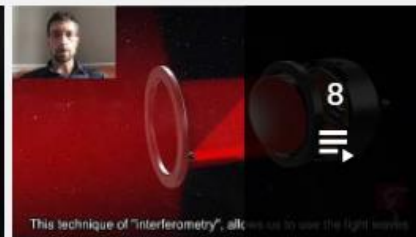
All playlists ▾

Created playlists



LPF - A Space Saga

[VIEW FULL PLAYLIST](#)



Introduction to LISA

[VIEW FULL PLAYLIST](#)



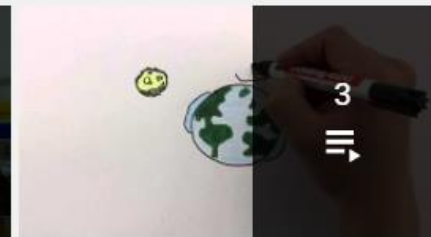
LISA Symposium XIII

[VIEW FULL PLAYLIST](#)



LISA Pathfinder

[VIEW FULL PLAYLIST](#)



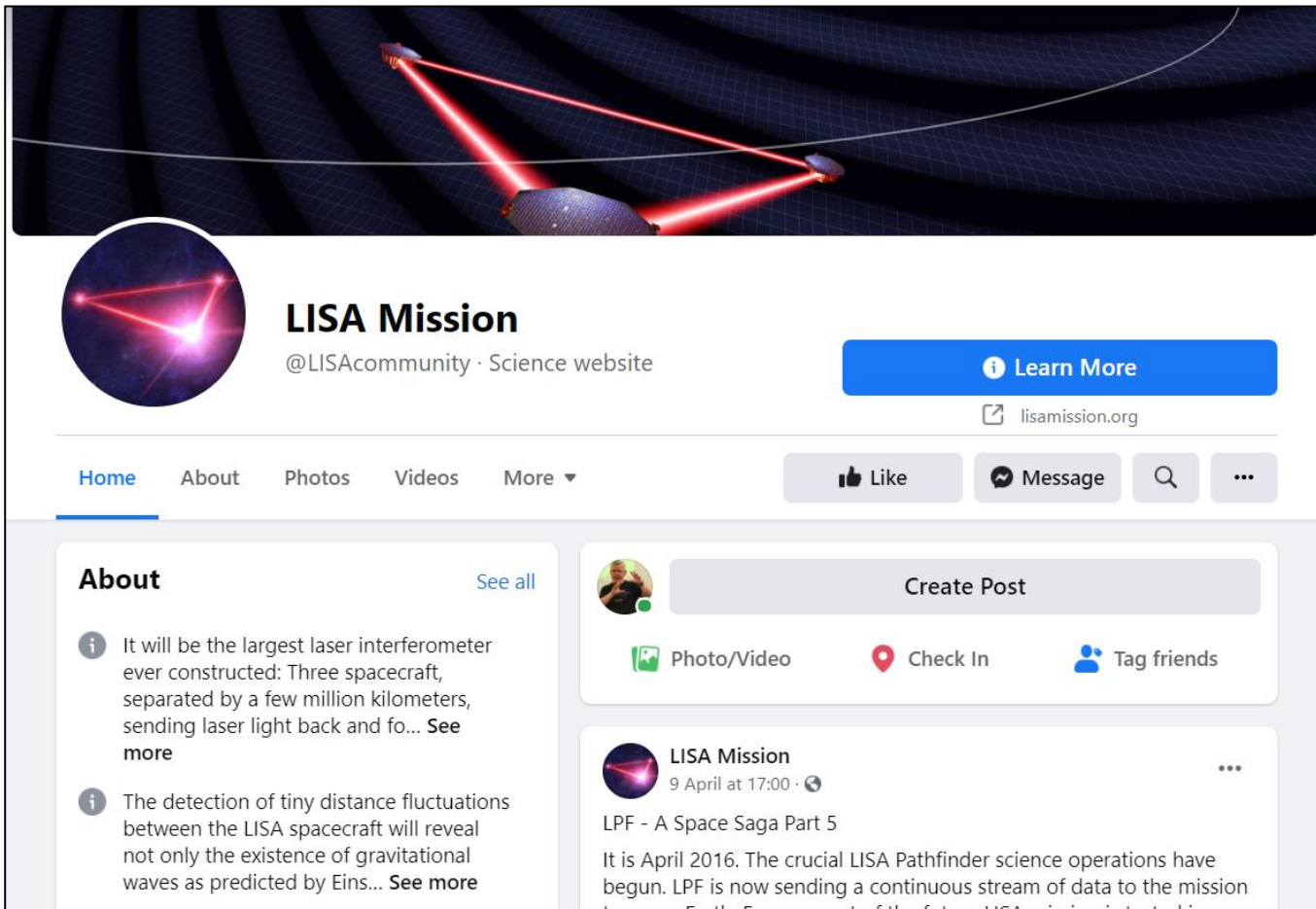
Gravity Ink.

[VIEW FULL PLAYLIST](#)

LISA Multimedia and Social Media

Find us on Twitter and Facebook!

(Instagram coming soon...)



The image shows the Facebook profile page for LISA Mission. The profile picture is a circular logo featuring a red laser interferometer. The cover photo is a large illustration of the LISA spacecraft formation in space, with three spacecraft and red laser beams forming a triangle. The name "LISA Mission" is displayed in bold, with the handle "@LISACommunity" and "Science website" below it. A blue "Learn More" button is visible, along with the website "lisamission.org". The navigation bar includes "Home", "About", "Photos", "Videos", and "More". The "About" section is expanded, showing two informational paragraphs. The first paragraph states: "It will be the largest laser interferometer ever constructed: Three spacecraft, separated by a few million kilometers, sending laser light back and fo... See more". The second paragraph states: "The detection of tiny distance fluctuations between the LISA spacecraft will reveal not only the existence of gravitational waves as predicted by Eins... See more". A "Create Post" section is visible with options for "Photo/Video", "Check In", and "Tag friends". A recent post is partially visible, titled "LISA Mission" and dated "9 April at 17:00", with the text "LPF - A Space Saga Part 5".



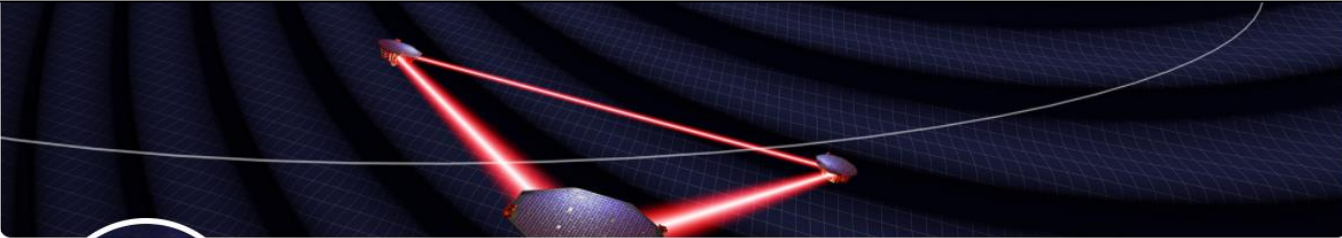
The image shows the Twitter profile page for LISA Mission. The profile picture is a circular logo featuring a red laser interferometer. The header shows "LISA Mission" with "1,156 Tweets" and a "Following" button. The bio reads: "Gravitational-wave detection from space. Three spacecraft, separated by million kilometers - the largest laser interferometer ever constructed." Below the bio is the website "lisamission.org" and "Joined March 2013". The statistics show "62 Following" and "11.4K Followers". A list of users followed is shown, including "LIGO_TheDocumentary, Les Guthman, and 136 others you follow". The navigation bar at the bottom includes "Tweets", "Tweets & replies", "Media", and "Likes".

Follow us at [@LISACommunity](https://twitter.com/LISACommunity)

LISA Multimedia and Social Media

Find us on Twitter and Facebook!

(Instagram coming soon...)



LISA Mission
@LISACommunity · Science website

[Learn More](#)
lisamission.org

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Like Message

About [See all](#)

- It will be the largest laser interferometer ever constructed: Three spacecraft, separated by a few million kilometers, sending laser light back and fo... [See more](#)
- The detection of tiny distance fluctuations between the LISA spacecraft will reveal not only the existence of gravitational waves as predicted by Eins... [See more](#)

Create Post

Photo/Video Check In Tag friends

LISA Mission
9 April at 17:00 · [Public](#)

LPF - A Space Saga Part 5

It is April 2016. The crucial LISA Pathfinder science operations have begun. LPF is now sending a continuous stream of data to the mission team on Earth. Every aspect of the future LISA mission is tested in a

LISA Mission
1,159 Tweets Following

LISA Mission @LISACommunity · Apr 26

Our @LISACommunity spans the world! This week we're joining a special #LISA_Canada workshop online, to highlight the fantastic potential of #LISA science to Canadian researchers in particle physics, astronomy, gravity and many other fields. More info at meetings.triumf.ca/indico/event/2...



5 17

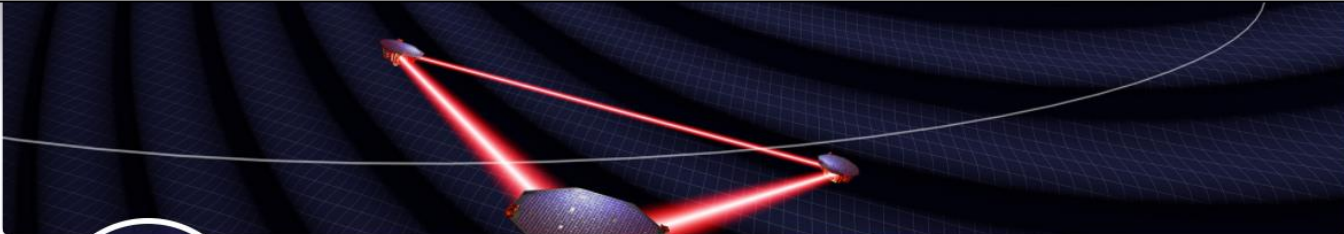
LISA Mission @LISACommunity · Apr 26

All through this week's #LISA_Canada online meeting we'll be live tweeting news and updates from the sessions - which begin 0800 Pacific Time on Tue 27 Apr. Watch this Space(-time)... and check out our #LISA Consortium pages too at lisamission.org



LISA Multimedia and Social Media

Find us on Twitter and Facebook!
(Instagram coming soon...)



LISA Mission
@LISACommunity · Science website

[Learn More](#)
lisamission.org

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- The detection of tiny distance fluctuations between the LISA spacecraft will reveal not only the existence of gravitational waves as predicted by Eins... [See more](#)

Create Post
Photo/Video Check In Tag friends

LISA Mission 9 April at 17:00 · 🌐
LPF - A Space Saga Part 5
It is April 2016. The crucial LISA Pathfinder science operations have begun. LPF is now sending a continuous stream of data to the mission team on Earth. Every aspect of the future LISA mission is tested in a

← **LISA Mission**
1,159 Tweets [Following](#)

Tweets Tweets & replies Media Likes

LISA Mission @LISACommunity · 10m
There's a growing community of #LISAcanda scientists working on #LISA science and taking part in this week's workshop. Meet Kristen Dage: @McGillMSI postdoctoral fellow working on ULX sources in globular clusters. (This photo tells us Kristen's really "buzzing" about #LISA 😄)



1 1 1

LISA Mission @LISACommunity · 5m
Kristen joined @LISACommunity in 2020 after completing a @michiganstateu PhD in astrophysics. Kristen is really interested in understanding sources, like ULXs, that could generate future #LISA signals.

1 1 1

Humans of LIGO



About LIGO
The Laser Interferometer Gravitational-Wave Observatory (LIGO) is a large-scale scientific experiment designed to detect gravitational waves as predicted by Einstein's General Theory of Relativity. The first LIGO observation made the first ever direct detection of gravitational waves coming from a collision of two black holes in 2015, a feat that was awarded the Nobel prize in Physics in 2017.

Humans of LIGO, a short timeline:

- The First Humans**
The project kicked off in August 2015 with the first humans sharing their stories via written responses to these questions:
- Thirsty the Raven**
Ravens, jutting out like beaks on the cooling system, at LIGO's "Classical" holes that moved up in the Government Wave Channel. These story bits got a well-deserved and much-loved guest appearance on the blog on Halloween.
- LGBT STEM Day**
The blog celebrated LGBTQ+ representation within the collaboration and continues to be a platform for their experiences.
- 30 Humans ...**
One year since its inception, the blog has received profiles over 30 humans and shared their stories. LIGO's social media handles:


Humans of LIGO
The LIGO Scientific Collaboration exhibits incredible diversity among its members, with people coming from all backgrounds and at various stages of their careers. Since August 2015, the Humans of LIGO project has brought individuals from the collaboration to the forefront and given them a chance to tell their story. It has showcased different aspects of their personalities, their thoughts and experiences to their hobbies and interests. Not only is it a platform for highlighting LIGO researchers, but it also offers the public a glimpse into their daily lives and life journeys.

Stats at a glance...

Pages by Country

Country	Pages
India	2308
United States	2197
United Kingdom	1732
Germany	1287
Canada	585
Australia	584
France	568

18+ Countries
100+ Institutions
1300+ Faces
1 Collaboration

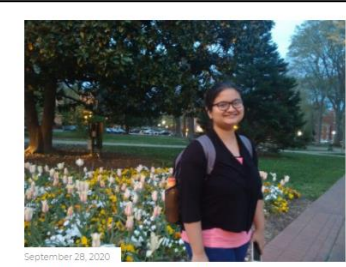


Pages

- Home
- About

Archive

Labels



September 28, 2020
DRIPTA BHATTACHARJEE
Post a Comment



May 27, 2020
ASHINI MODI
Post a Comment



May 04, 2020
ROBERTO COTESTA



May 14, 2020
LEO TSUKADA
Post a Comment

2017 NOBEL PRIZE

#NobelsAndUs

"I am very proud of having led the Collaboration at the time of the discovery, but most of all I'm proud of having seen the Observatories and the Collaboration grow into a large, diverse, and collaborative team."

Gabriela Gonzalez
Professor at Louisiana State University
Former LSC Spokesperson

2017 NOBEL PRIZE

#NobelsAndUs

"@NobelPrize laureate Kip Thorne co-authored one of the defining textbooks on gravitation for every @LIGO and Virgo scientist! It beautifully explains Einstein's relativity and has built excitement for #GravitationalWaves for decades. My hardcopy has moved with me across three countries so far."

David Keitel
EU-funded postdoc at Glasgow University, United Kingdom, originally from Germany

LIGO-INDIA 8 MARCH 2021

Women of LIGO-India

Meet the women behind this Mega-Science project



Debarati Chatterjee
Professor

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

<https://www.ligo-india.in/gravitymatters/>

We are researchers who study black holes! Ask Us Anything!

Discussion

UPDATE: Thanks so much for your questions! That's all the time we have for today's AMA, but be sure to visit <https://www.nasa.gov/black-holes> for the latest updates about how NASA studies black holes.

It's Black Hole Week! We've brought together a panel of black hole experts from around the world to answer your questions about these fascinating and often misunderstood objects.

A black hole is an astronomical object with a gravitational pull so strong that nothing, not even light, can escape it. A black hole's "surface," called the event horizon, defines the boundary where the velocity needed to escape exceeds the speed of light, which is the speed limit of the cosmos. Matter and radiation fall in, but they can't get out! Despite their reputation as the vacuum cleaners of the universe, a black hole's gravity behaves no differently than it would around any other object - it's only when you get very close that things start to get weird.

Researchers study black holes using an array of space telescopes and ground-based observatories that are funded and operated by NASA, European Space Agency (ESA), and National Science Foundation (NSF). By combining as many signals as possible — including nearly every wavelength of light, gravitational waves, and particles like neutrinos — scientists are unraveling the secrets of these elusive objects. In addition, researchers at many of these organizations also produce visualizations of matter around black holes to better understand the theories governing them and to help us make sense of our observations.

Here's your chance to ask experts from NASA, ESA, NSF's NOIRLab, Laser Interferometer Gravitational-Wave Observatory (LIGO), National Radio Astronomy Observatory (NRAO), Stanford University, and Vanderbilt University your questions about black holes — including what we think they're like, how we find and study them, and what we still want to learn about them.

Scientists answering your questions starting at 2:00 p.m. EDT include:

- **Adi Foord (AF)** | Porat Postdoctoral Fellow, Stanford University/KIPAC
- **Cecilia Chirenti (CC)** | Associate Researcher/Associate Professor in Applied Mathematics, University of Maryland College Park, NASA GSFC, Federal University of ABC (UFABC)
- **Joan Wrobel (JW)** | Scientist, National Radio Astronomy Observatory
- **Julia Scharwächter (JS)** | Associate Scientist, Gemini Observatory/NSF's NOIRLab
- **Karan Jani (KPJ)** | Research Assistant Professor in Physics & Astronomy, Vanderbilt University
- **Nora Luetzgendorf (NL)** | JWST/NIRSpec Instrument Scientist and Study Scientist for LISA, European Space Agency
- **Michele Vallisneri (MV)** | Research Scientist, NASA JPL
- **Sera Markoff (SM)** | Professor of Astrophysics, University of Amsterdam & Event Horizon Telescope

r/space

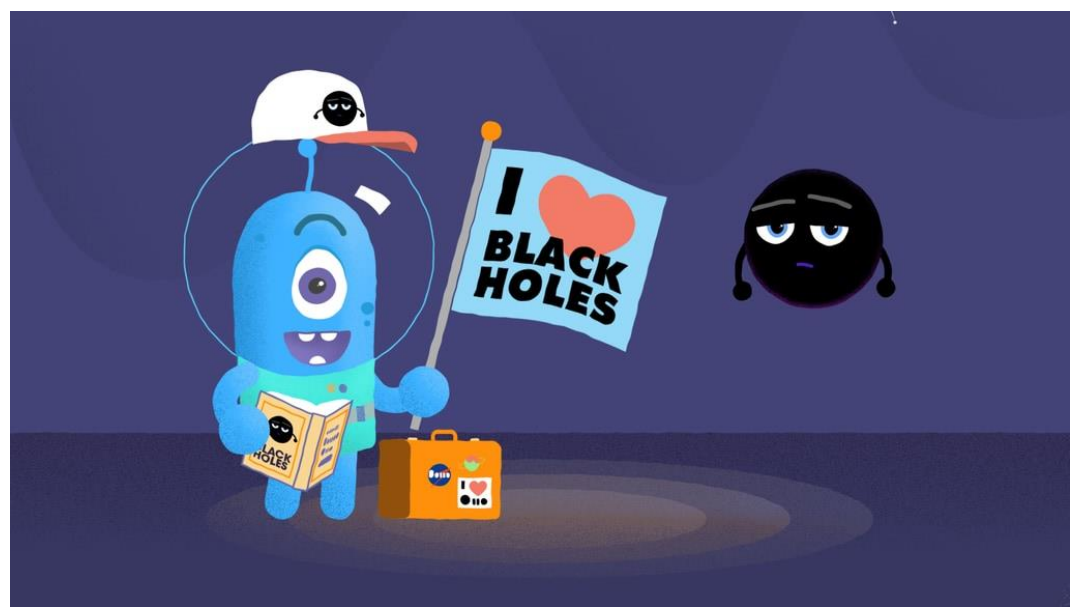
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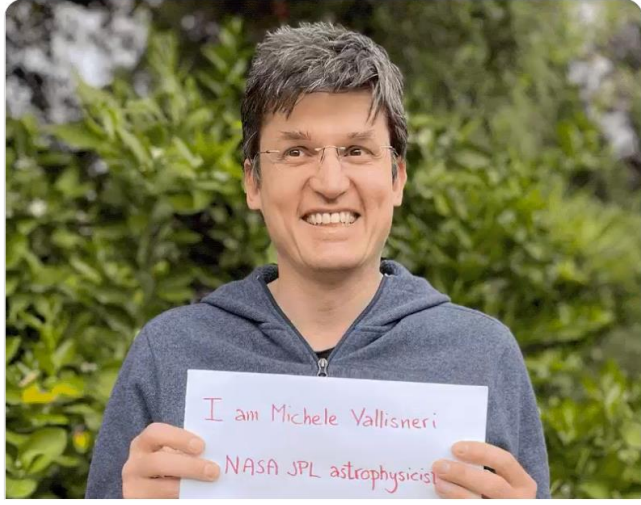
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NASA Universe @NASAUniverse · Apr 16

Thank you for stopping by and joining us on @reddit to chat and ask questions to experts about black holes! Check out the questions and answers here: redd.it/ms7i07 #BlackHoleWeek



NASA Universe @NASAUniverse · Apr 16

Thank you for stopping by and joining us on @reddit to chat and ask questions to experts about black holes! Check out the questions and answers here: redd.it/ms7i07 #BlackHoleWeek





LISA Mission

1,156 Tweets

Following



LISA Mission @LISACommunity · Apr 22

What should we call a group of #BlackHoles? @GravityKelly was brainstorming this last month with @LISACommunity @NASA & @LIGO colleagues, and in #BlackHoleWeek we asked our follower for ideas too. Now @NYTScience takes up the challenge! ●●●●●....



What Do You Call a Bunch of Black Holes: A Crush? A Scream?
There are pods of whales and gaggles of geese. Now astronomers are wondering which plural term would best suit the most enigmatic entity...
[nytimes.com](https://www.nytimes.com)

12

21

57



#BlackHolesCollectiveNoun

Lots of engagement during Black Hole Week!

Tons of great ideas...

With our LIGO and NANOGrav friends we plan to organise a shortlist and public vote.



Kelly Bockelmann

8 March · 🌐

The NASA LISA Study Team is having waaay too much fun thinking of a word for a collective of black holes (like a murder of crows). What do you think they should be called? I'll share some of ours after you share yours!

19

39 comments 6 shares

Like

Comment

Share

View 33 more comments



← **Tweet**



Quite Interesting ✓
@qikipedia



Astronomers at @LIGO are looking for a good collective noun for a group of black holes. Suggestions include a crush, a mosh pit, a silence, an enigma, a void, and a disaster. You can propose your own with the hashtag #BlackHolesCollectiveNoun.

12:34 PM · Apr 28, 2021 · TweetDeck

237 Retweets 159 Quote Tweets 1,059 Likes



Elizabeth Fraser 🕷️ 🇪🇺 🐸 ❤️ @Frauhaus · 2h



Replying to @qikipedia and @LIGO

An Augor - auger is a tool for making holes, augur is an event or circumstance that may foreshadow good or ill. Spelt here with an o to visually reinterpret and visually signal the wholeness of a black hole singularity



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Quite Interesting ✓
@qikipedia

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LIGO ✓
@LIGO

Official Twitter of the LIGO Scientific Collaboration. We detect gravitational waves! Email: questions@ligo.org

What's happening

In memoriam · Last night

Apollo 11 astronaut Michael Collins, who orbited the moon during the first surface landing, has died at age 90



Trending with [Michael Collins](#)



<https://www.igrav.org/>

Welcome to IGrav

Engaging people throughout the world in exploring the exciting field of gravitation

Mission

The mission of IGrav is to engage people throughout the world in exploring the exciting field of gravitation, and in particular gravitational-wave and multi-messenger astrophysics. IGrav will accomplish this mission through the creation, sharing and dissemination of a variety of educational and outreach materials.

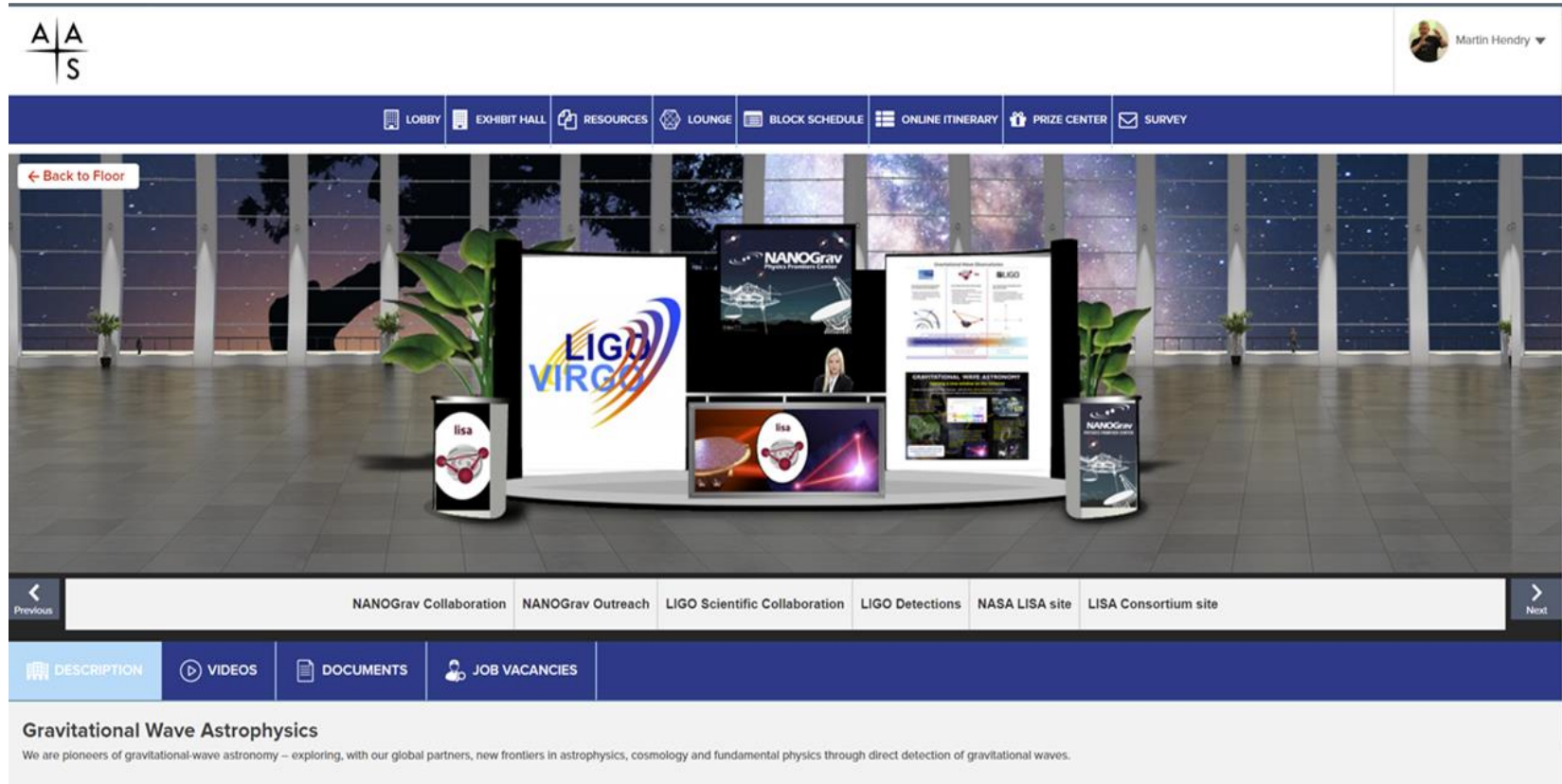
About

Welcome to IGrav.

Members

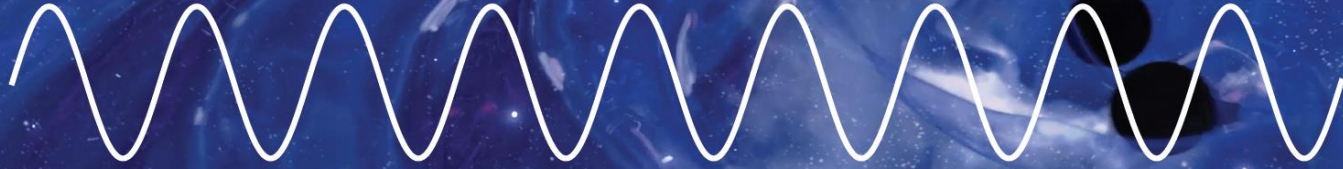
Joint (with LIGO/Virgo + NANOGrav) GW Astronomy **virtual exhibits** at AAS + APS + SACNAS meetings (and presence at other online exhibitions)

We need help developing and editing virtual materials



KEY TASK: HELP US REVIEW / UPDATE OUR (VIRTUAL) BOOTH CONTENT

National Aeronautics and Space Administration



Ultra-Compact Binary

www.nasa.gov

Background Image: S. Barke/UFlorida



NASA is partnering with ESA on a space-based gravitational-wave (GW) observatory. Rather than producing an *image* or *spectrum* by detecting electromagnetic radiation, a GW observatory produces a *waveform* by detecting the change in displacement of widely separated test masses to measure the ripples in space-time caused by gravitational radiation emission, revealing source properties otherwise unobtainable. A GW observatory will measure signals from a wide range of previously invisible sources, revolutionizing astronomy and leading to a deeper understanding of the universe.

Ultra-Compact Binaries

Our galaxy contains ~50 million UCBs comprised of white dwarfs, neutron stars and black holes. These generally evolve slowly, with nearly circular orbits. This population contains a fossil record of stellar evolution, including cataclysmic variables and supernovae Ia progenitors.

NP-2017-12-536-GSFC

For more information, visit: elisascience.org and pcos.gsfc.nasa.gov/studies/L3/

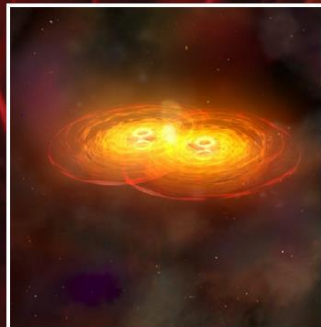
National Aeronautics and Space Administration



Supermassive Black Hole Merger

www.nasa.gov

Background Image: S. Barke/UF/Florida



NASA is partnering with ESA on a space-based gravitational-wave (GW) observatory. Rather than producing an *image* or *spectrum* by detecting electromagnetic radiation, a GW observatory produces a *waveform* by detecting the change in displacement of widely separated test masses to measure the ripples in space-time caused by gravitational radiation emission, revealing source properties otherwise unobtainable. A GW observatory will measure signals from a wide range of previously invisible sources, revolutionizing astronomy and leading to a deeper understanding of the universe.

Supermassive Black Hole Mergers

Supermassive black holes (SMBHs) inhabit the centers of galaxies. Understanding the mechanisms of SMBH growth is an enduring problem in astrophysics. Some models suggest that they grow via galaxy mergers. Merging supermassive black holes will be strong gravitational wave sources, and allow testing of these models.

NP-2017-12-538-GSFC

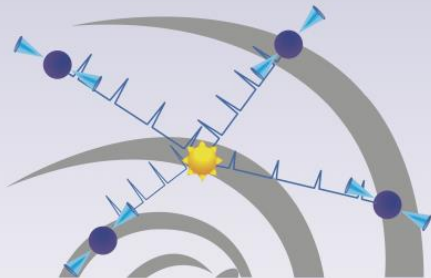
For more information, visit: elisascience.org and pcos.gsfc.nasa.gov/studies/L3/

Gravitational Wave Observatories



North American Nanohertz Observatory for Gravitational waves (NANOGrav)

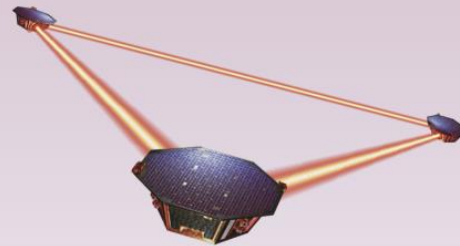
- Galactic-scale observatory monitoring millisecond radio pulsars (15cm-75cm)
- Sensitive to changes in distance of ~ 100 km over kiloparsecs.



lisa

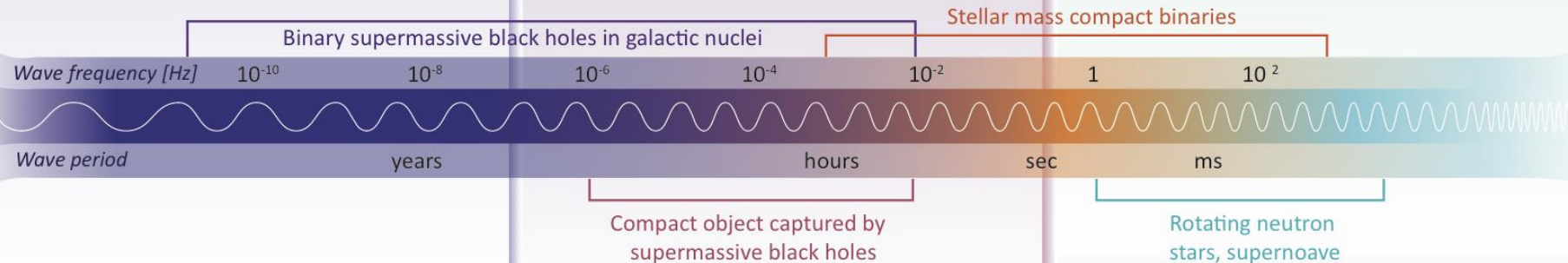
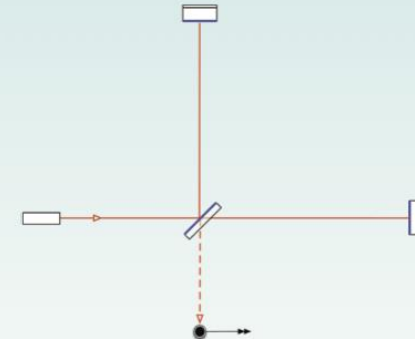
Laser Interferometer Space Antenna (LISA)

- Space-based laser interferometer
- 3 spacecraft orbiting the Sun, each housing free-falling test masses
- Distances between test masses measured with 1064 nm lasers
- Sensitive to changes in distance of $\sim 10^{-11}$ m over millions of kilometers.



Laser Interferometer Gravitational wave Observatory (LIGO)

- Earth-based laser interferometers
- Two interferometers using 1064 nm lasers
- Working with the Virgo detector in Italy
- Sensitive to changes in distance of $\sim 10^{-18}$ m over kilometers



Gravitational-Wave Astronomy

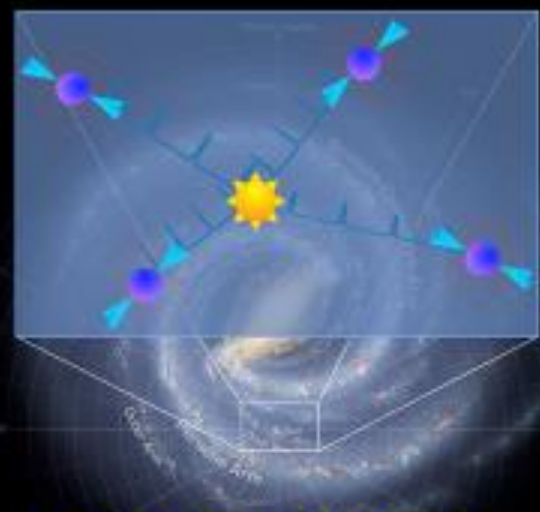
Opening New Windows on the Cosmos



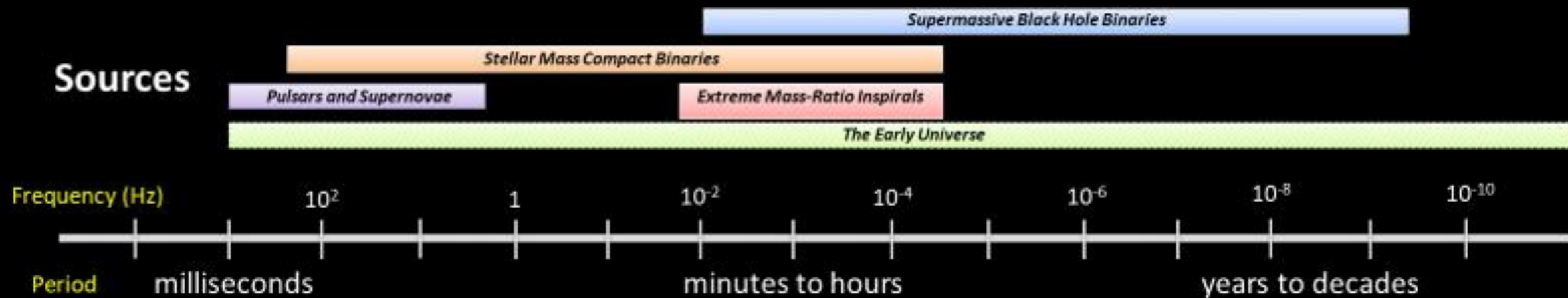
Ground-Based Interferometers

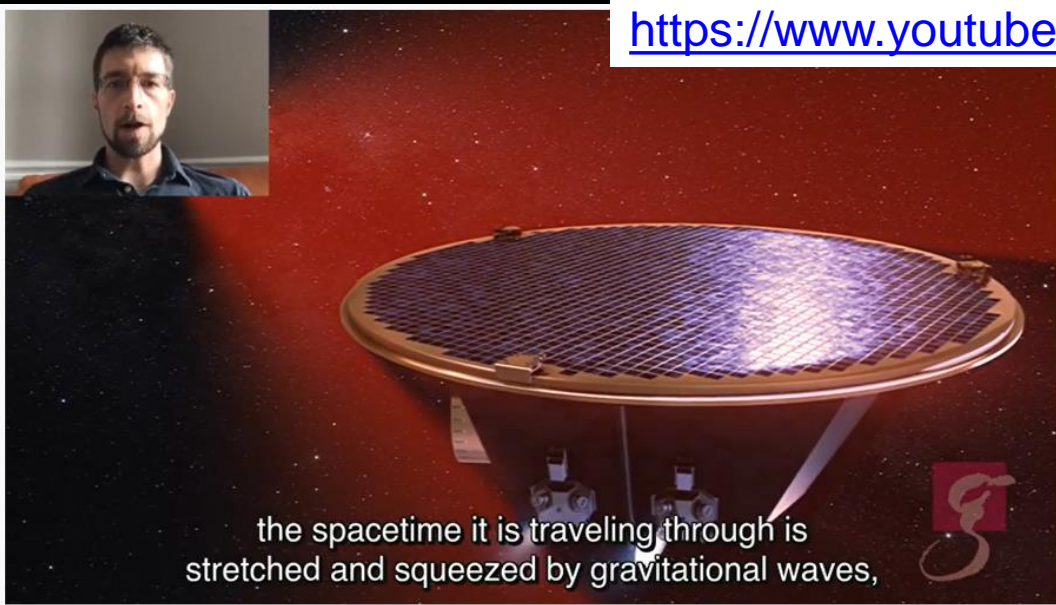


Space-Based Interferometers



Pulsar Timing Arrays



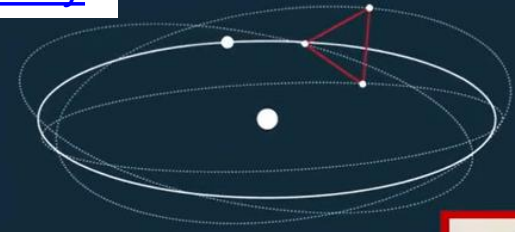


the spacetime it is traveling through is stretched and squeezed by gravitational waves,



How Does LISA Work?

LISA: SPACE



Location

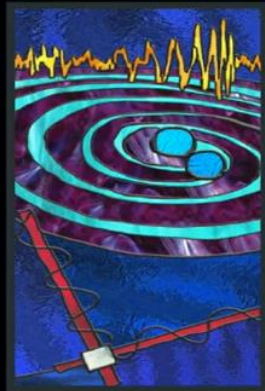


LIGO: GROUND

is obviously that LIGO is on the ground, and LISA will be in space.

What is the difference between LISA and LIGO?

Multimessenger Minute



Credit: IceCube Collaboration



Almost everything we know about the distant universe

LISA Multimessenger Minute



COMPACT BINARY SOURCES

These are systems of gravitationally-bound compact objects

Types of LISA Sources

The O3a catalog: Apr 1 to Oct 1 2020

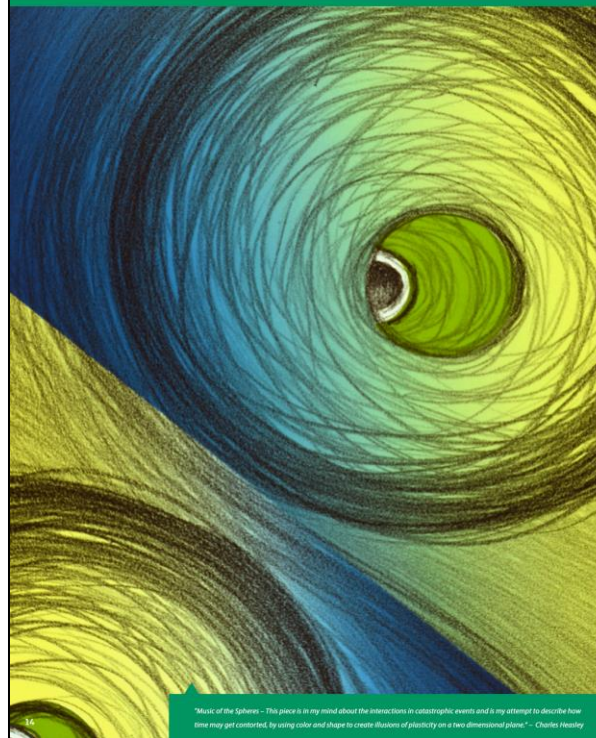
Half-time harvest of LIGO and Virgo's third observing run p.11

Art, music, and gravitational waves

When gravitational waves ripple across the arts world p.14

... and the importance of mental health and good supervision p.26

Art and music ...



"Music of the Spheres - This piece is in my mind about the interactions in catastrophic events and is my attempt to describe how time may get distorted, by using color and shape to create illusions of plasticity on a two dimensional plane." - Charles Heasley

... and gravitational waves

Where imagination meets science

Gravitational wave observations have captured imaginations around the world. In this article we hear from artists, musicians, and scientists on their gravitational wave inspired artistic works.

Einstein's Unfinished Symphony
My work is usually created by combining expressive or gestural hand drawn elements with photographic or light sensitive printing matrices. My specialized interest has been primarily in the area of photo print processes of the late eighteenth through the early part of the twentieth century. I have always had an interest in the way the sciences dovetail with the arts and since about 2001 I have been



Leon Trimble with Gravity Synth at the Live Performers Meeting, Roma.

watching with great anticipation the way LIGO and the other gravitational wave observatories have proved successful in their objectives. I first became aware of the investigations when I read an article that was published in the New York Times book review of Marcia Bartusiak's book review of Marcia Bartusiak's book "Einstein's Unfinished Symphony". This work became a springboard for my imagery and subsequent prints over the past twenty years.

Gravity Synth
Gravitational waves signals can be converted into sound, but did you know that the technology used to detect them can be used to make music? Gravity Synth does just that: it is a musical instrument created by combining a Michelson interferometer with a modular synthesizer. It is a collaboration between audiovisual artist Leon Trimble and University of Birmingham researchers, Aaron W. Jones, Conner Gettings, Hannah Middleton, Anna Green and Andreas Freise. In 2016, Leon and Hannah met at an art/science "Worlds Collide" event in Birmingham and got chatting about black holes making chirp signals when they collide and converting gravitational-wave signals into sound. This led to many more discussions between Leon and the research group members. Meanwhile, Aaron designed and built the interferometer for use in live performances.

Charles Heasley



I am now in the final stages of completing a suite of eight lithographs drawn on stone with color superstructure formed on photo sensitive lithographic plates, which I am dedicating to Marcia Bartusiak and her profound ability to take such a complex subject and translate through verbal language the ideas of science. Her works reveal the real creative individuals and their vast achievements through the science of the LIGO experiment.

is a member of the Department of Art and Art History at the State University of New York College of Cortland. He teaches in the Graphic Design and Digital Media program and conducts courses in analog and digital Photography, Motion and Graphic Design, and Printmaking.



GW190425: illustration of a binary neutron star merger by Aurore Simonnet

Currently, I am working on conceptual designs for a collaborative art installation, ideally for LIGO Hanford's new Exploration Center. How can kinetic sculptures merge with augmented reality to create an educational environment for gravitational wave astronomy?

To learn more, please visit:
www.AnastasiaAzure.com/GW

Anastasia Azure



creates art inspired by the elegance of science. Her three-dimensional sculptures are handwoven on a traditional floor loom. She enjoys climbing trees and meditating during sunset.



"Phase Evolution" by Anastasia Azure. Handwoven wire and nylon above a glass orb.

LISA Consortium Advocacy & Outreach Working Group



Kelly Holley-Bockelmann
Vanderbilt Univ.



Martin Hendry
Univ of Glasgow



Laser Interferometer
Space Antenna

Ref : LISA-LCST-SGS-WPD-XXX	
Issue : 0	Revision : 6
Date : 2020/06/18	Page : 1/ 10

LISA Advoreach Work Packages

N/Ref :	LISA-LCST-SGS-WPD-XXX
Title	LISA Advoreach Work Packages
Abstract	<p>The LISA Consortium Advocacy and Outreach (aka <i>Advoreach</i>) Working Group aims to promote, support, and coordinate:</p> <ul style="list-style-type: none">• communication and regular exchange of information between the mission teams and working groups within the Consortium, and other relevant stakeholders;• coordination, as appropriate, with outreach projects and activities carried out by other Gravitational Wave communities (e.g. LIGO, NANOGrav, etc);• outreach to the wider astronomical community – particularly in common science areas, advocating for LISA and emphasising the complementarity of LISA science;• promotion and raising awareness of LISA to non-scientific audiences, specifically the general public, journalists, politicians, and other decision makers – in terms of the exciting science questions LISA will address the , the remarkable technology that will enable this, data analysis and LISAs impact for society.

advoreach@lisamission.org

advoreach-chairs@lisamission.org

