NSF Big Ideas: WoU-MMA
Windows on the Universe - The era of Multi-Messenger Astrophysics

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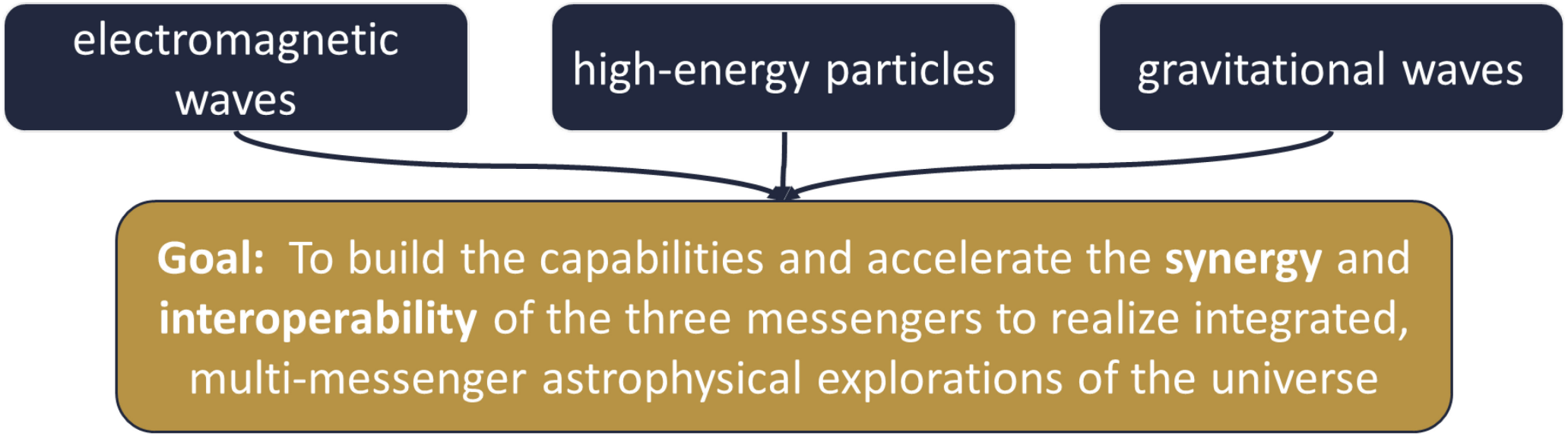
NSF's Big Idea: Windows on the Universe

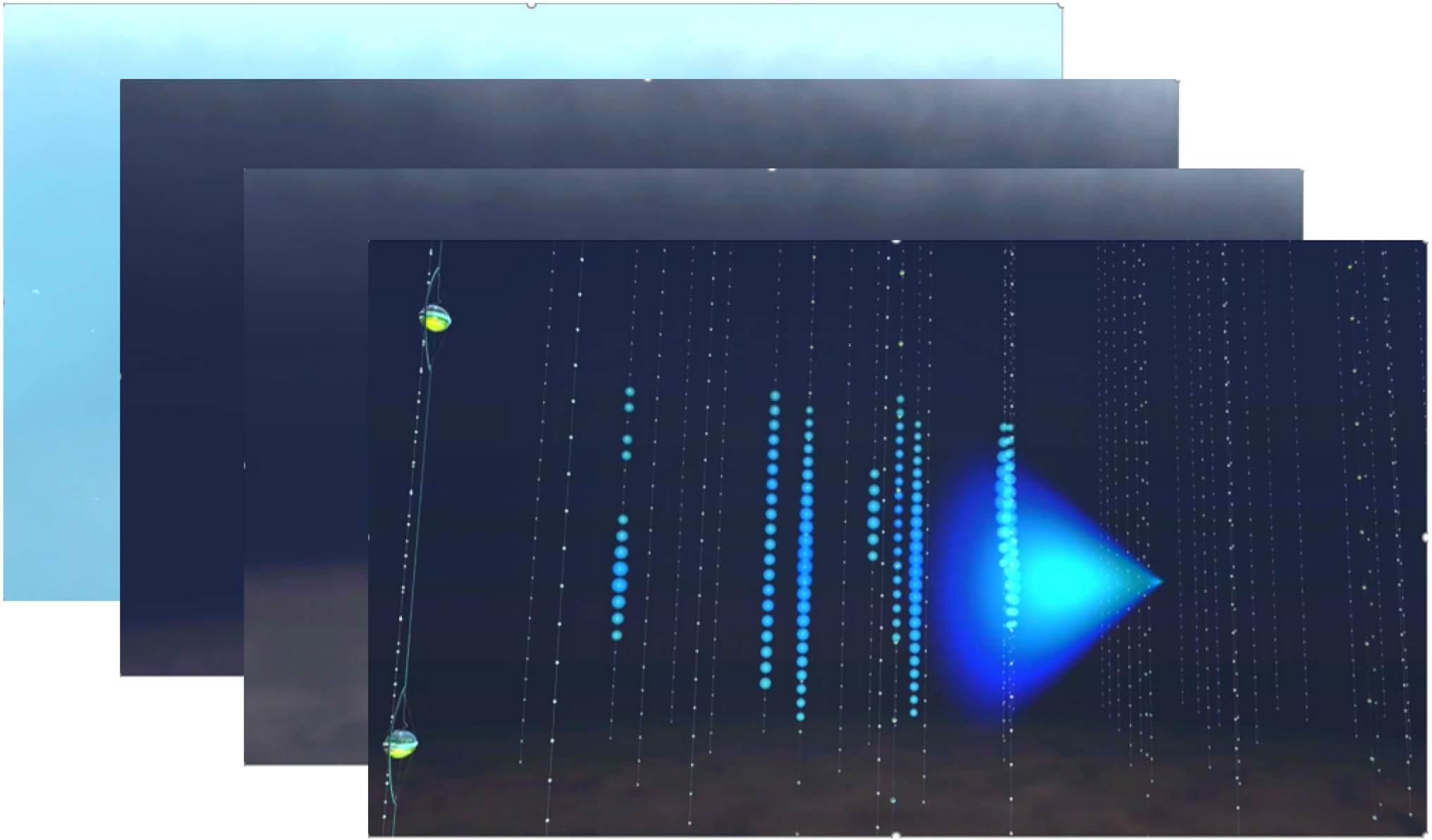


WoU-MMA addresses 2 or more simultaneous messengers

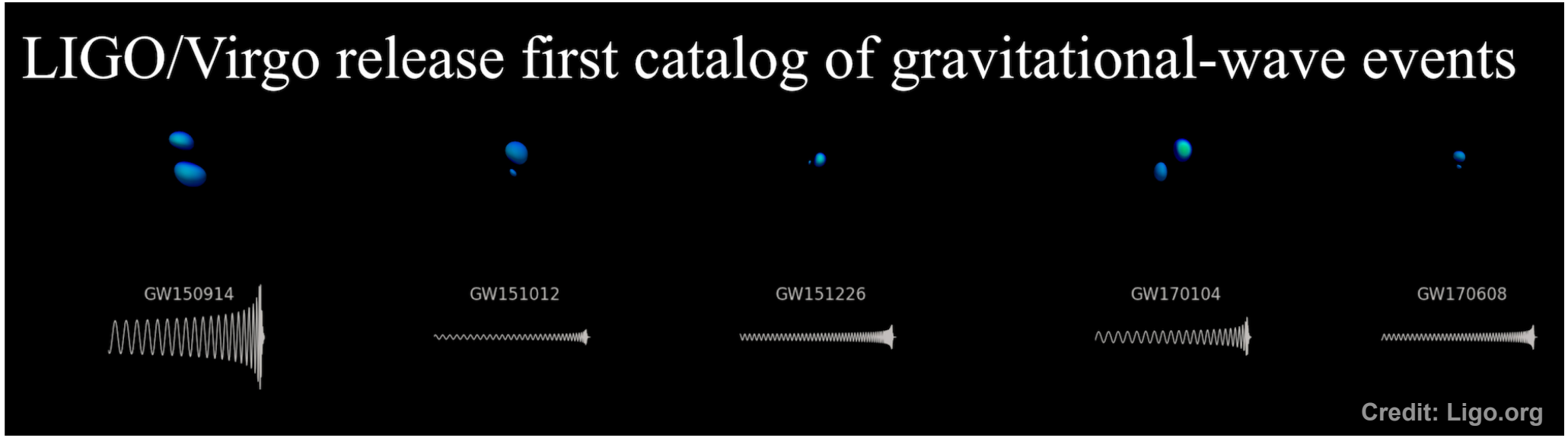
2017 was a good year for WoU-MMA observations

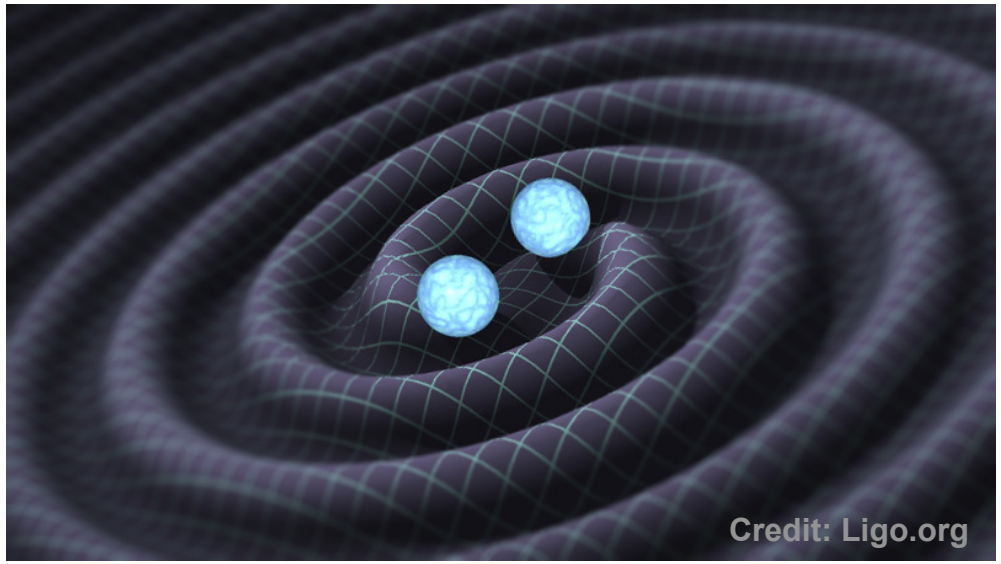
- Two significant MMA events in 2017
  - IceCube observed neutrinos from a Blazar
    - Fermi and other telescopes saw light from the same source
    - Blazar - a special type of quasar with a relativistic jet pointing along our line of sight and emitting neutrinos which are undeflected on their path to the earth
    - IceCube – a cubic km neutrino observatory at the south pole
  - LIGO/VIRGO observed a binary neutron star merger
    - Space based telescopes see gamma radiation 1.7 seconds after the merger signal, and ground based observatories see visible light 11 hours later
    - Likely a kilonova w/complex evolution … time dependent Plasma & Nuclear Physics processes at work
    - LIGO – Interferometric gravity wave detector with 4 km arms
    - Upgrades have led to unprecedented sensitivity – Run 3 (O3) started in April

Blazar TXS 0506+056 ⇒ Coordinated E&M and HE Particle Observations



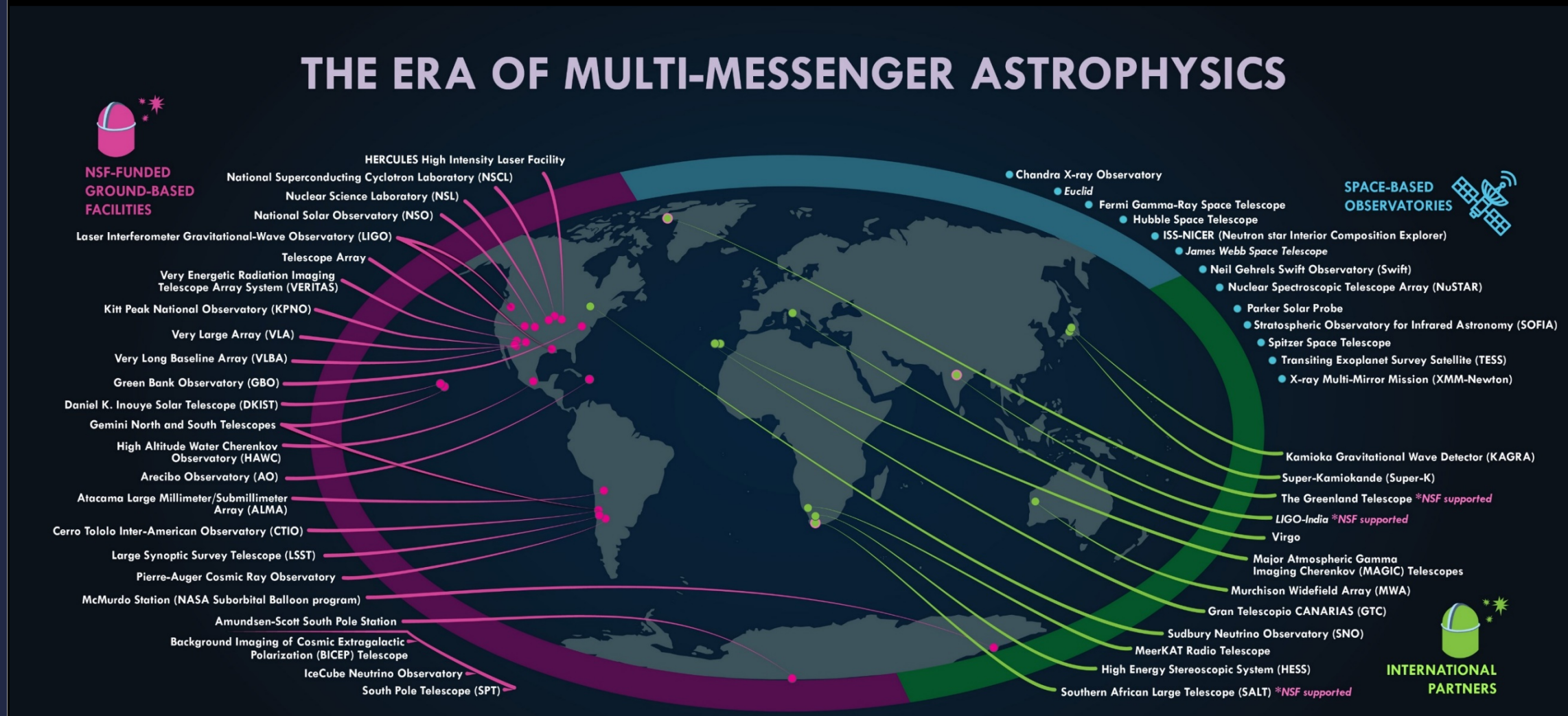
BH Binary Mergers - The chirp heard around the world





- 40 “confident detections”
- A new event every week
  - https://gracedb.ligo.org/latest/
- Including 1 binary neutron star merger which was observed optically, w/ γ rays and across the E&M spectrum (+1)
- GW170817 - A tremendous stimulus for Astrophysics including Astronomy, Nuclear, Particle, Plasma & Space science

Multi-messenger astrophysics is a global enterprise



Windows on the Universe Implementation

- WoU-MMA Program Description (18-5115) posted
- Proposals submitted to participating programs in MPS/AST, MPS/PHY, GEO/OPP
- Proposals are reviewed within programs (often co-reviewed by multiple programs)
- *Coordination Group* determines common framework for allocation of stewardship funding ($30M annually)
- *Implementation Group* makes consensus recommendations for WoU funding

Qualifying Criteria & Areas for Investment

Qualifying Criteria

- Coordination: Hardware and other infrastructure to coordinate observations involving more than one messenger
- Observations: […] observations of sources of more than one messenger including existing observatories, experiments and data archives as well as the development of new capabilities
- Interpretation: Theory, experiment and simulations […] to understand or interpret observations

Areas for Investment

- Enhancing […] theoretical, computational and observational activities within the scientific community
- Building dedicated midscale experiments and instrumentation
- Exploiting current facilities and developing next generation observatories

Fiscal 2019 – WoU-MMA

- $30M from WoU-MMA awarded in FY19
- 66 awards (full or co-funded w/ PHY/AST & OMA)
- Roughly 2/3 went for support of individual investigators
- The remaining 1/3 was split between Instrumentation and Facilities

A few examples

- PI Community (individual investigators)
  - Ice Cube – F. Halzen (Univ. of Wisconsin)
    - Support for 19 institutions to do the scientific analysis of data taken with the IceCube neutrino detector
- Instrumentation
  - SNEWS: a Super Nova Early Warning System - R. Lang et al.
    - Analysis of neutrino detector data to provide a prompt alert for an impending supernova … hours before it will be visible in the sky
- Facilities
  - SCIMMA – P. Brady et al.
  - Scalable Cyberinfrastrucure Institute for Multi-Messenger Astrophysics

An example that highlights Individual Investigators

- Five collaborators from Michigan State University
  - "Windows on the Universe: Nuclear Astrophysics at the NSCL" - PI A. Spyrou
  - Home of the National Superconducting Cyclotron Laboratory (NSCL) and future home of the Facility for Rare Isotope Beams (FRIB)
- Nuclear Astrophysics
  - Interpretation of astronomical observations using light, gamma rays, gravitational waves and neutrinos

    requires an understanding of the nuclear processes that create the messengers
- An experimental program at NSCL
  - Restage in the laboratory the nuclear reactions that occur in super nova explosions and neutron star mergers
  - Direct impact on interpretation of observations from GW170817 and direct feedback to models, simulations and theory

An example that highlights instrumentation and E&M counterparts

- "The CGWA in the Era of Multimessenger Astronomy"
  - Supplement to an award to PI Mario Diaz
- Hardware upgrades to enhance an existing telescope used by the University of Texas Rio Grande Valley. Wide field of view.
- Improve the capability for detection of prompt electromagnetic counterparts to gravitational wave events – out to 200 Mpc
- Provides support for broadening participation, inclusion of underrepresented groups, and further developing a workforce skilled in multi-messenger astrophysics

An example that highlights synergy with other programs

- An award made jointly between Harnessing the Data Revolution (HDR) and Windows on the Universe (WoU)
  - "A Framework for Data Intensive Discovery in Multimessenger Astrophysics" - PI Patrick Brady
- Supports the conceptualization phase for SCIMMA:
  Scalable Cyberinfrastructure Institute for Multi-Messenger Astrophysics
- The purpose of the proposed Institute: a community-recognized provider of cyberinfrastructure services that foster data fusion, communication, collaboration, analysis, and dissemination of results in MMA.
  - A collaboration between data scientists, computer scientists, astronomers, astroparticle physicists, and gravitational wave physicists
- This phase will include development of algorithms, databases, and computing and networking cyberinfrastructure to support multi-messenger observations

Windows on the Universe Team

MPS AD – Anne Kinney
GEO AD – William Easterling

Windows Coordination Group – Policy and Framework for Implementation
Co-Chairs: Jean Cottam Allen (MPS/PHY) & Ralph Gaume (MPS/AST)

MPS/AST: Ed Ajhar, Joe Pesce
MPS/PHY: Pedro Marronetti
GEO/OPP: Vladimir Papitashvili
OD/OISE: Mangala Sharma
ENG/IIP: Richard Schwerdtfeger

Windows Implementation Group
Co-Chairs: Jean Cottam Allen (MPS/PHY) & Ralph Gaume (MPS/AST)

MPS/AST: Matt Benacquista, Jim Neff, Nigel Sharp
MPS/PHY: Pedro Marronetti, Slava Lukin, Jim Thomas
GEO/OPP: Vladimir Papitashvili
MPS/OAD: Clark Cooper, Swati Sureka

AAAC Meeting 2019

Jim Thomas