Multi-messenger astronomy in the perspective of global collaboration

9 January 2018

David Shoemaker
Spokesperson, LIGO Scientific Collaboration
Secretary, Gravitational-wave International Committee

LIGO-G1800049

Case Study: GW170817

- Coalescence of two neutron stars, seen in
  - Gravitational waves
  - Gamma rays
  - X, optical, IR, Radio
  - (not neutrinos, but that's information too)
- Morning speakers gave an overview of the event and the astrophysics
- Scientists and instruments from around the world contributed
- Many things worked well – some by luck, some by planning; some lessons learned, stimulating following comments
- Here want to stimulate discussion about how to optimize future science that requires collaboration on the **global** scale
  - Beyond the scope of APPEC
- Will call out some specifics for the LIGO Scientific Collaboration and the Virgo Collaboration (LVC)

Collaboration planning and execution

- Different sociologies and natural scales for collaboration
  - From efforts of 1 person to groups of thousands
  - Groups with histories of collaborative work and those in competition
  - Need to seek solutions that don't compromise science and yet which are minimally invasive
    - Change might be needed to realize the synergy of MMA
- **1st priority: agreements in place, in advance, to share enough data promptly to ensure that no science is lost**
  - Between observer teams
  - Between observatories
  - GCN, AMON, or other highly reliable and universal communication solution
- For LVC 'O3' observing run, start in late 2018
  - anticipate a mixture of Public Triggers and MoU-specific information

Collaboration planning and execution

- Then: Maximize synergy by coordination between groups/collaborations
  - Technology development sharing
    - LIGO and Virgo 'Advanced' detectors as case study
  - Data transfer and Computing coordination
    - Low latency distribution
    - Cloud/web large-scale computing access
    - User friendly, flexible use paradigms (wrappers, schedulers of choice)
  - Data release policies
  - Publication policies
  - Work these out before detections, please!
- → **These considerations lead to Agreements between scientists and between collaborations**

Establishing Global Roadmaps

- Originating in the scientific community
- Interdisciplinary
- Geographically Global
- What exists currently?
  - ApPEC (Europe)
  - Astronet (Europe)
  - APPIC – AstroParticle international Committee
  - APIF – AstroParticle Physics International Forum
  - GWs: GWIC Roadmap covers the world but only for GWs; GWAC starting to coordinate agencies
  - US Astronomy Decadal covers broadly the US Astronomy field, addresses LISA but not ground-based GW instruments
  - Elsewhere?

Establishing Global Roadmaps

- What's the best level and style of 'Global Roadmaps'?
  - Meta-roadmaps? An actual unified roadmap?
  - Close informal collaboration/cooperation in preparation?
  - Different audiences, cultures, and timelines…
- **Attempt a unified MMA roadmap?**
  - Value seen in giving a complete view of the available instruments at various epochs – and what is missing, to help motivate new instruments
  - Need an international organization to organize and offer imprimatur
  - IUPAP a candidate

Covering the spectrum

- **Want to ensure that there is a continuum of instruments available:**
  - All the relevant ‘particles’ or messengers covered
  - North/South hemispheres, 24h/day covered
  - Adequate baselines for required resolution
  - Of growing capability as technology evolves
  - On all planning timescales
- E.g., GW detectors: Small numbers of instruments due to cost
  - Need for three or more operating to extract source information
  - Expect to have 5 in the mid-term (~2025)
    - LIGO (2 US, 1 India)
    - Virgo (Italy)
    - KAGRA (Japan)
- Need to take ‘off line’ for improvements in the near- and mid-term
- Need to ensure continuity through to 3G (new observatories)
- Then….3G instruments (Europe, US…Southern Hemisphere?)
- And LISA!

Covering the spectrum

- → **Collaboration (or coordination) among global agencies crucial**
  - 'GWAC' (Gravitational-Wave Agency Correspondents) an effort to achieve this for GW detectors
  - APIF is the astroparticle international forum of funding agencies
  - Is there an e.g., ESFRI-NSF-ESO-NASA-ESA general coordinating body?
  - Something that covers all MMA domains?
- **Wish to find – or create – an appropriate funding agency forum to receive a**
  - **Worldwide,**
  - **Community-generated,**
  - **Multi-Messenger Astrophysics Roadmap**

APPEC Roadmap on this subject

- 16. Global collaboration and coordination: Some research directions warrant a global strategy. In some cases, this may be due to substantial capital requirements or running expenses (e.g. for multi-messenger facilities); in others, it may be because of the advantages in pursuing complementary technologies (e.g. for next-generation Dark Matter searches and the measurement of neutrino properties). In some instances, cooperation between different observatories working as a single interconnected network can lead to much better precision or much deeper understanding (e.g. in the field of gravitational-wave detection or, ultimately, all multi-messenger observatories).

- APPEC will continue to seek collaboration and coordination with its partners worldwide – scientists and funding agencies – to advance the design, construction, sustainable exploitation (including computing needs) and governance of the next-generation worldclass large research infrastructures required to achieve the scientific discoveries of which we all dream. APPEC will explore ways of aligning the realistically available funding in Europe to maintain the excellent discovery potential of European scientists. Project governance, management, computing needs and running costs all require serious attention.