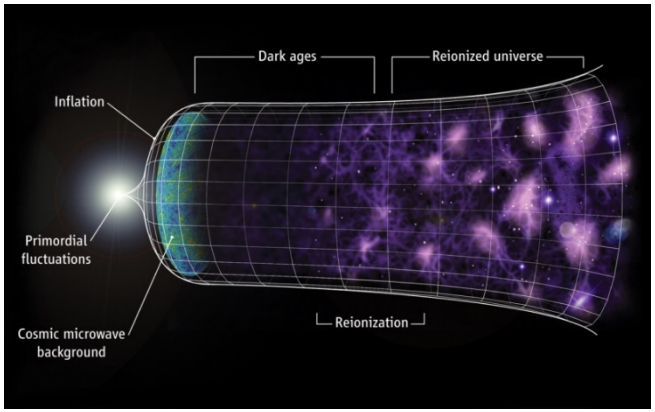
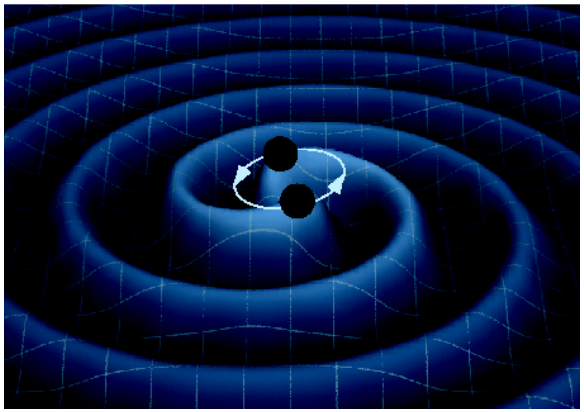
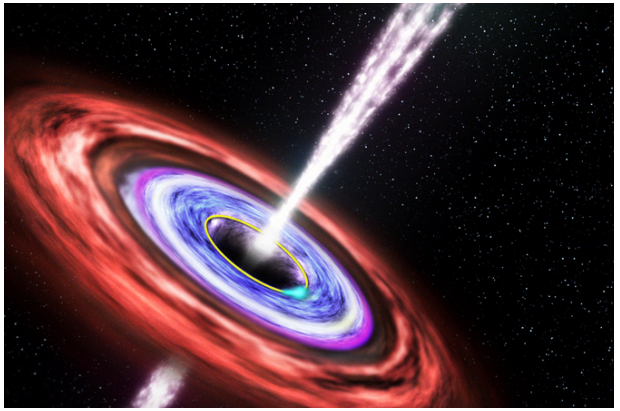
Physics of the Cosmos Program Analysis Group Report







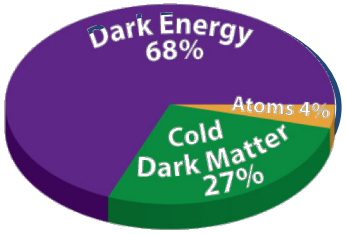
John W. Conklin
University of Florida (jwconklin@ufl.edu)
Chair, Physics of the Cosmos Program Analysis Group

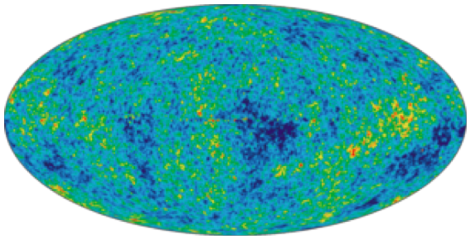
23 October 2018

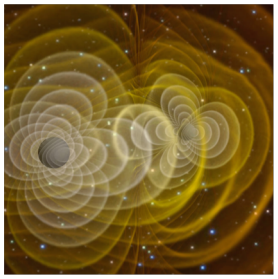
Outline

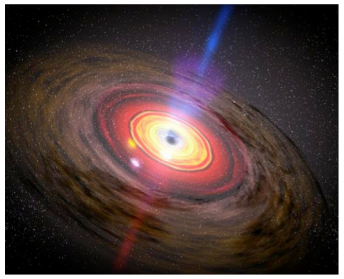
- **Introduction to PhysPAG (reminder)**
- **Multimessenger Astrophysics SAG**
- **Highlights and Meetings**

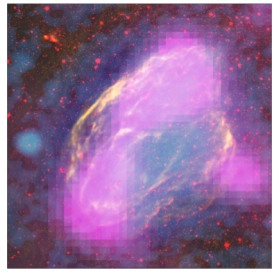
Physics of the Cosmos Science Objectives











- Increase our knowledge of dark energy
- Precisely measure cosmological parameters governing evolution of the universe and test inflation hypothesis of Big Bang
- Test validity of Einstein's General Theory of Relativity and investigate nature of spacetime
- Understand formation and growth of massive black holes and their role in evolution of galaxies
- Explore behavior of matter and energy in its most extreme environments

PhysPAG EC Membership

Name	Affiliation	Area of Expertise	Term Ends
John Conklin (Chair)	Univ. of Florida	GW SIG	December 2019
Jim Beatty	Ohio State Univ.	CR SIG	December 2019
Sylvain Guiriec	George Washington Univ.	Gamma-Ray SIG	December 2019
Kelly Holley-Bockelmann	Vanderbilt Univ.	GW SIG	December 2019
Kevin Huffenberger	Florida State Univ.	CoSSIG/IP SIG	December 2020
Ralph Kraft	SAO	X-Ray SIG	December 2018
Henric Krawczynski	Washington Univ. in St. Louis	Gamma-Ray SIG	December 2018
Igor Moskalenko	Stanford Univ.	CR SIG	December 2018
James Rhoads	GSFC	CoSSIG	December 2020
Graça Rocha (Vice Chair)	JPL	IP SIG/CoSSIG	December 2020
John Tomsick	UC Berkeley	Gamma-Ray SIG / X-Ray SIG	December 2019
Abigail Vieregg	Univ. of Chicago	IP SIG / CR SIG	December 2020
Nicolas Yunes	Montana State Univ.	GW SIG	December 2020

Goals of the MMA SAG

1. **Identify science goals that could be achieved by combining different astrophysical messengers measured by current and future ground- and space-based observatories**

2. **Identify measurements that can be made by existing, currently approved, and future planned ground- and space-based observatories that could contribute to MMA in 2020's, early 2030's**

3. **Determine how these enhanced or new science goals align with NASA Astrophysics Division's scientific priorities.**

4. **Identify the key qualitative technical drivers that are needed to achieve these science goals (e.g. wavelength, sensitivity, sky localization, latency, …)**
   - If feasible, determine desirable performance levels for each

What is the MMA SAG?

- **Community-driven; community-owned; open to all**
- **MMA SAG consists of astrophysicists from multiple disciplines within the PhysPAG and COPAG**
- **While inspired by GW BNS observation, MMA SAG is not necessarily GW-specific**
- **Chair, John W. Conklin, University of Florida**
  PhysPAG Co-chair, John Tomsick, UC Berkeley
  COPAG Co-chair, Suvi Gezari, University of Maryland
- **Terri Brandt has been a big help!**

MMA SAG Source Teams

- **Organized around astrophysical sources (not λ or spectrum)**
  - Goal: form teams with people interested in the same sources but observing via different messengers
  - Asked for volunteers to lead/co-lead the source teams.
  1. **AGN, SMBH binaries, EMRIs**
     - Sarah Burke-Spolaor & Bindu Rani, co-leads
  2. **NS+NS, NS+BH, WD-WD binaries, GRBs**
     - Eric Burns, Colleen Wilson-Hodge, co-leads
  3. **Stellar mass BH-BH binaries**
     - Peter Shawhan, Saavik Ford*, co-leads
  4. **FRBs, SNe Ia, SN remnants**
     - Geoff Clayton, lead
- **~bi-weekly Source Team telecons & ~monthly full telecons**

Outcomes of the MMA SAG

- **The SAG will document its findings in one or more publically available white papers**
  - Delivered to APAC in summer 2019

- **These white papers *will not* advocate for any particular mission, but provide analysis of MMA landscape in 2020's**

MMA SAG White Papers in Progress

- **AGN, SMBH binaries, EMRI's**
  1. Extreme Mass Ratio Inspirals
  2. Multi-Messenger science of the growth of supermassive binary black holes
  3. AGN Multi-messenger: Neutrinos
  4. High-energy emission: key challenges
- **NS+NS, NS+BH, WD-WD binaries, CCSNe**
  5. Neutron star mergers
  6. Galactic Binaries
  7. Core Collapse Supernovae
- **Stellar Mass BH-BH binaries**
  8. Multi-Messenger Astrophysics Opportunities with Stellar-Mass Binary Black Hole Merger Events
  9. Multi-Messenger Supermassive Black Hole Binary Statistical Inferences
- **FRBs, SNe Ia, SN Remnants – still in progress**

Highlights & SIG Updates (1/4)

- **Great Observatories SAG - R. Kraft (PhysPAG EC rep)**
  - GO SAG originated in COPAG EC, but significant interest among PhysPAG community, and particularly XRSIG. Roughly 40 participants.
  - Broad charter to address the following questions:
    - What are options for maintaining, in next 10-20 years, multi-wavelength coverage from space?
    - Can anticipated scientific goals be realized with a combination of flagship, smaller missions?
    - Should longevity be key criteria for considering future large missions? What are kinds of science that require simultaneity versus sequential observations? Are longevity and concurrence critical?
    - What is role of international partnerships in meeting these goals?
    - Are there (non-traditional) technical solutions that are being discussed or should be studied that can help?
    - To what degree can loss of wavelength coverage be partially mitigated through the use of existing NASA archives?
  - Had several telecons and divided into five working groups - four science themes and one for missions and facilities.
  - Each WG will develop one or more white papers

Highlights & SIG Updates (2/4)

- **GW SIG**
  - The GW community is organizing space-based GW white papers with NLST
  - Helping organize the LISA Consortium reboot
  - Organizing sessions at AAS (invites out and some accepts in)

- **CoSSIG**
  - Community is preparing Science White Papers

- **CR SIG**
  - Held Mini-Symposium at Spring APS meeting in Columbus, OH
    - Featured results from key experiments, including Voyager as exited heliosphere
  - Community is preparing the White Paper process

Highlights & SIG Updates (3/4)

- **X-Ray SIG**
  - Preparing for XR SIG meeting at Seattle AAS meeting
  - Community is gathering information from large mission studies about plans for submitting WP's to Decadal. Will share this info to X-Ray community to ensure full community participation

- **Gamma-ray SIG**
  - The gamma-ray community held two workshops, telecons for initiating, continuing drafting science white papers for 2020 Decadal.
    - 1st workshop at the George Washington University, May 23-24, 2018
    - 2 telecon meetings
    - 2nd workshop at the Clemson University, October 1, 2018
  - Community is drafting five science white papers, which will respond to multiple thematic areas

Highlights & SIG Updates (4/4)

- **IP SIG**
  - The CMB community is working on Science White Papers:
    - Terri Brandt participated in CMB meetings (started with CMB-S4 ~3 weeks ago)
    - Community is approaching collaborators to review white papers, ensure the whole set of interests are represented, namely:
      - Interests in space and ballooning are well represented
      - Various people reading more than one draft at a time, so that content is rationalized and consistent among groups and between science topics

Past PhysPAG meetings/telecons

- **PhysPAG EC telecon, 4 October**
  - Discussed community plans for Astro2020 Decadal
  - Seattle AAS meeting planning
  - Update from me on previous APAC meeting

- **PhysPAG EC telecon, 14 August**
  - Thai Pham Update on Technology Gap solicitation process
    - Gearing up to help PCOS/COR/ExEP with strategic tech gaps in summer 2019
  - Seattle AAS meeting planning
  - DCL regarding nominations for the PhysPAG EC

Upcoming PhysPAG/SIG Meetings

- **Winter AAS meeting, 6–10 January, 2019, Seattle, WA**
  - Joint-PAG session on Sunday, 6 January
  - Thursday, 10 January, 1.5-hour sessions each, in order:
    - GW SIG
    - PhysPAG Session
      - Will host four speakers on the topic of Multimessenger Astrophysics
    - Gamma-Ray SIG
    - X-Ray SIG

- **April APS, 13-16 April, Denver, CO**
  - Will have PhysPAG/PCOS and SIG sessions