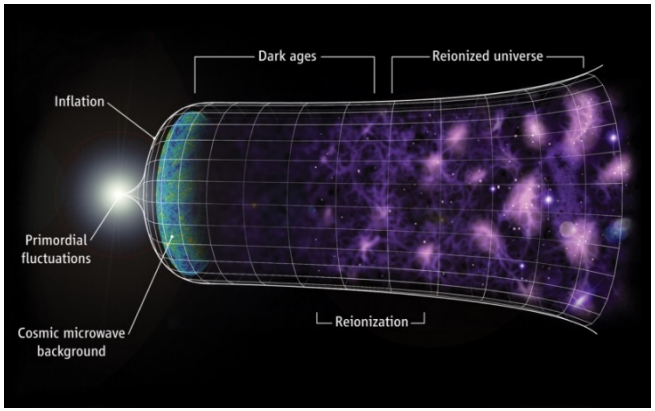
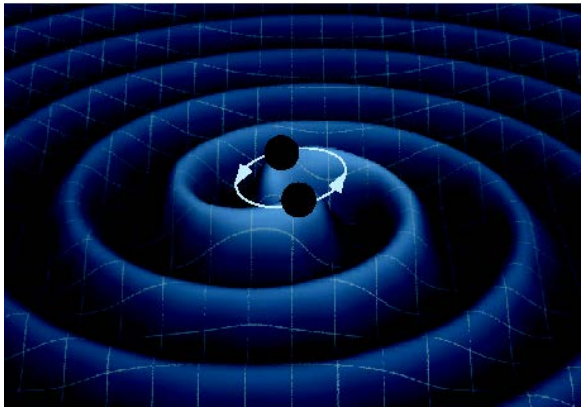
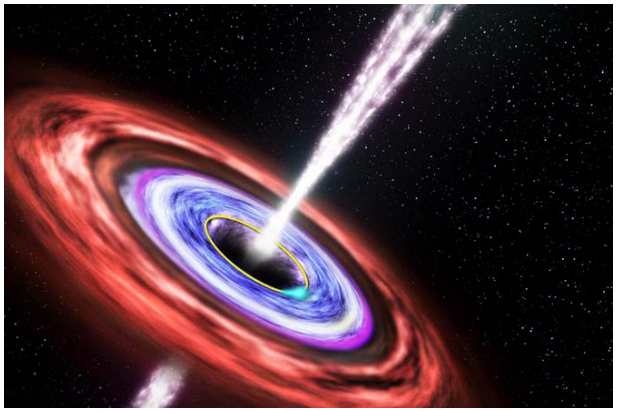
# Physics of the Cosmos Program Analysis Group Report





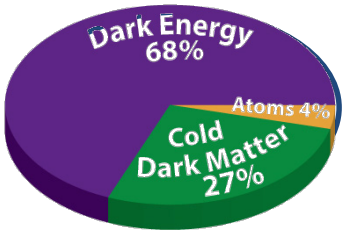
**John W. Conklin**
University of Florida (jwconklin@ufl.edu)
*Chair, Physics of the Cosmos Program Analysis Group*

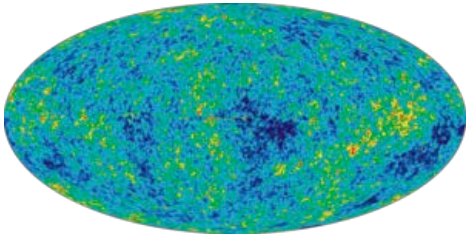
*24 July 2018*

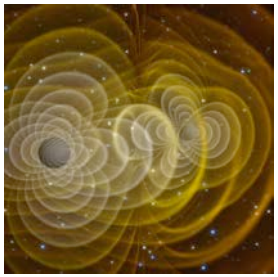
# Outline

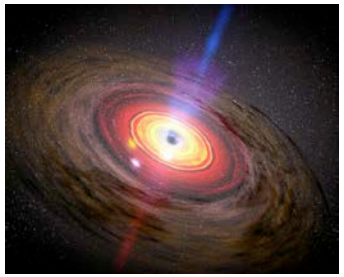
- **Introduction to PhysPAG (reminder)**
- **Community Survey on Decadal Timing**
- **Multimessenger Astrophysics SAG**
- **Highlights and Meetings**

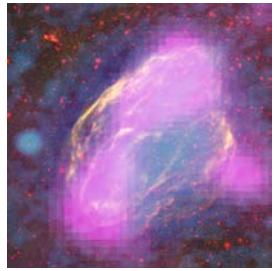
# Physics of the Cosmos Science Objectives









- **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

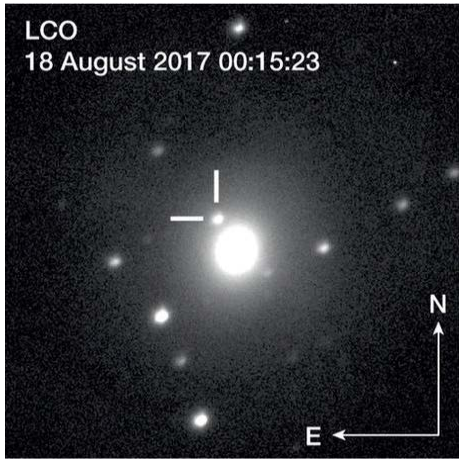
| Name | Affiliation | Area of Expertise | Term Ends |
|---|---|---|---|
| John Conklin (Chair) | Univ. of Florida | GWSIG | December 2019 |
| Jim Beatty | Ohio State Univ. | CRSIG | December 2019 |
| Sylvain Guiriec | George Washington Univ. | GammaSIG | December 2019 |
| Kelly Holley-Bockelmann | Vanderbilt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

# Community Survey on Decadal Timing

- **COPAG (Paul Scowen) assembled survey to allow community to give input on:**
  - Can decadal be effective in context of JWST, WFIRST uncertainties?
  - What steps can we take to ensure that decadal can effectively assess highest science priorities, recommend a balanced program
- **Survey open to PCOS community 8-13 May 2018**
  - PCOS represented 54% of all respondents
  - Responses consistent among PCOS, COR, ExEp
- **PhysPAG assisted COPAG in writing/editing report on short time scale**

# MMA SAG Inspiration

- **August 2017 BNS merger discovery demonstrated power of MMA**
  - Gamma-rays detected by *Fermi*
  - Gravitational waves detected by LIGO/Virgo
  - Flurry of follow-up observations by international astronomical community



# 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**

# 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
- **If possible, MMA SAG will produce earlier white papers, publicly available, that could be considered by the decadal committee**
- **These white papers *will not* advocate for any particular mission, but provide analysis of MMA landscape in 2020's**

# MMA SAG Activities Thus Far

- **Announced activity to full PhysPAG and COPAG email lists**
- **Created MMA SAG website and sign-up Google form**
  - Thanks Terri Brandt for the help!
- **Currently have 59 astrophysicists signed up, representing the diverse community (EM, GW, particles, PhysPAG and COPAG)**
- **First full MMA SAG telecon 8 June**
  - 34 people dialed in
  - Provided background and goals of the SAG
  - Decided to form a substructure within the SAG (Source Teams)

# 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, ?, co-leads
  4. **FRBs, SNe Ia, SN remnants**
     - Geoff Clayton, lead
- **~weekly Source Team telecons & ~monthly full telecons**

# Highlights & SIG Updates (1/2)

- **Nominated Ralph Kraft to be PhysPAG representative on the COPAG Great Observatories SAG**

- **XRSIG**
  - Held session at HEAD Special Meeting on High Energy Astrophysics in the 2020s and Beyond, March, Rosemont, IL
  - Preparing a session at Seattle AAS meeting in January, 2019

- **CRSIG:**
  - Held minisymposium at April APS, Columbus, Ohio. Agenda included latest exciting Voyager cosmic ray results from outside heliosphere.
  - Although not official CRSIG event, COSPAR meeting in Pasadena includes significant representation from our community, including over 100 presentations

# Highlights & SIG Updates (1/2)

- **GWSIG**
  - LISA Consortium has been rebooted; many GWSIG members participate/lead working groups within this structure, e.g. Fundamental Physics, Cosmology, Astrophysics
  - LISA Symposium held two weeks ago in Chicago
  - Organizing white papers through the pcos website:
    - https://pcos.gsfc.nasa.gov/sigs/gwsig/whitepapers.php
  - GW white paper clearing house via this Google form:
    - https://goo.gl/forms/KiTBmL1jndMRampf1
- **GammaSIG**
  - Held workshop to discuss strategy for Decadal White Papers, May 23-34 at George Washington University
  - Started drafting a gamma-ray WP:
    - https://pcos.gsfc.nasa.gov/sigs/grsig/whitepapers-workshop.php
  - Plan to have a follow-up telecon soon.

# PhysPAG/SIG Meetings

- **Past Meetings**
  - April APS meeting, April 14-17, 2018, Columbus OH
    - Minisymposia: PCOS, GWSIG, CRSIG, GammaSIG, IPSIG
  - Summer AAS meeting, 3-7 June, 2018, Denver, CO
    - I participated as PhysPAG rep in joint NASA/NSF Town Hall on MMA

- **Upcoming meetings**
  - Winter AAS meeting, 6–10 January, 2019, Seattle, WA
    - Planning under way