Planning for the Decadal: Space, Balloons and CMB-S4

August 2017

Broad Context - Prep for Decadal 2020

- Communicate breadth of science goals: those we own (r, Neff), those that also appeal to the broader astrophysics community
- Present a compelling plan to the agencies, specifically both NSF and NASA
- Present a coherent plan - how all components work together, ground, balloons, space

Broad Context - Prep for Decadal 2020

- NASA only invests in technology development or balloon payloads that lead to a future space mission.
- NASA invests only in what the decadal panel recommends
- Many of us (most? all?) recognize the strengths of a future CMB space mission, the complementarity with sub-orbital, and of keeping NASA engaged with CMB

Strengths of Space/Ground

- Unparalleled view of the entire sky → Access to the lowest ℓ
- Unparalleled frequency coverage all in one instrument/data set
- Unparalleled stability + high instantaneous sensitivity → characterization of systematic uncertainties

Planck 2015 XIII

Bock et al. 2009

- Higher resolution access to the highest ℓ
- Long integration times
- Flexibility to change / fix / adapt

NASA Process for 2020

- `Inflation Probe' study funded and ongoing:
  - Probe of Inflation and Cosmic Origin = PICO (?)
- Designing a mission in the $400M-$1000M cost range

PICO Information

- Steering Committee: Bennett, Dodelson, Page
- Executive Committee: Borrill, Bock, Crill, Devlin, Flauger, Jones, Hanany, Knox, Kogut, Lawrence, McMahon, Pryke, Trangsrud - Weekly Telecons
- 7 working groups: fundamental physics (Flauger), extragalactic science (Battaglia), galactic science (Chuss), data challenge (Knox), Imager (Hanany), Spectrometer (Kogut), Systematics (Crill), [Technology (McMahon)] - Weekly/Periodic Telecons
- Wiki: https://z.umn.edu/cmbprobe
- Mailing list: cmbprobe@lists.physics.umn.edu

NASA Process for 2020

- Study will produce a 50 pg. report + cost estimates
- Report due in 12/2018
- Report will be submitted to NASA and to the Decadal Panel
- Desired/Likely outcome: Panel recommends a funding wedge for Probe Line. Specific Probes are competed later (~2022/3)

Developing a Decadal Panel Strategy

- We should give the panel a coherent story otherwise it would write the story for us.
- When you give it a coherent story, it listens
- A candidate story is
    - S4 will produce great science and should move forward immediately.
    - A space probe would also probe fantastic science and is compelling on its own
    - The two data sets would robustly extract all science possible from the CMB
    - The agencies should continue to support the technologies needed to field these experiments, and for balloons to make supporting measurements.

Comments about the story

- Unlikely that PICO and S4 will both be recommended to proceed: should we lay out an explicit phased plan (like in previous decade)?
    - No need to do so in the current decadal process
- Need to coordinate what is claimed by S4 and PICO about capabilities, so that there is no confusion. For example: need for high frequency bands for dust removal.
- S4 / PICO costs are not that far apart. Is this an issue for S4?

Developing a Decadal Panel Strategy

- Option: common workshop to develop the complementarity case
  - part of next S4 meeting? (April / May?)
  - 1 of 2.5(?) days
  - describe design of PICO, science capabilities + targets, discuss science complementarity (what can be achieved with both data sets), discuss technology development for both efforts
- Highlight complementarity in relevant reports
  - CDT; PICO study; S4 Science Book V2; S4 whitepaper; …
- Highlight common technologies + cross-fertilization in technology development; recommend participation of all agencies in developing the technologies

Additional Slides

Additions

- Decadal: NASA is the third leg
- Coordinated message:
    - AI: real concern is when we're interfacing with S4. Both S4 and Probe concept need to be careful to give the same message, lest NASA HQ decides that only one is needed. Including things ground doesn't get us that space does. Don't want HQ to think that the CMB community thinks a ground mission alone can get the full range of science.
    - AI: It is important that both ground based and NASA side are saying the same thing. Don't want mixed messages. Maybe be best couched in terms of sigmas - sigmar, sigmanf