To: Interagency Task Force on CMB Research (TFCR)

Task force members

James Bock (JPL)
Sarah Church (Stanford)
Mark Devlin (U. Penn)
Gary Hinshaw (GSFC)
Andrew Lange (Caltech)
Adrian Lee (Berkeley)
Lyman Page (Princeton)
Bruce Partridge (Haverford)
John Ruhl (Case Western)
Max Tegmark (MIT/U. Penn)
Peter Timbie (Wisconsin)
Bruce Winstein (Chicago)
Mathias Zaldarriaga (Harvard)

Agency observers

Kathy Turner (DOE)
Robin Staffin (DOE)
Michael Salamon (NASA)
Paul Hertz (NASA)
Nigel Sharp (NSF,AST)
Beverly Berger (NSF,PHY)
Vladimir Papitashvili (NSF,OPP)

Thank you joining the Task Force. The purposes of this note are:

1) to tell you of the expectations and schedule for the Task Force and to arrange for the meetings,

2) to suggest some procedures,

3) to focus our thinking by providing a draft outline of our final report to the agencies.

CHARTER and EXPECTATIONS

A good place to begin is with the letter I received from Kathy Turner, Michael Salamon and Nigel Sharp which is, in effect, a charter for the committee.

"Thank you for agreeing to chair the interagency Task Force on CMB Research (TFCR). This group will report to the agencies, through the InterAgency TFCR Working Group (IATWG) as part of our coordinated response to "Connecting Quarks to the Cosmos" (the Turner report).

The function of the TFCR is to address the basic question of how we can measure the CMB polarization. To quote the OSTP report, "The three agencies will work together to develop by 2005 a roadmap for decisive measurements of both types of CMB polarization. The road map will

address needed technology development and ground-based, balloon-based, and space-based CMB polarization measurements."

One cannot divorce polarization from the CMB itself, which is why the title of this group does not include polarization. We prefer to think of the outcome as a trajectory, with a suggested time-line, possible milestones to be met along the way, points for reflection on the earlier stages and possible redirection of effort dependent on the prior outcomes, and so on.

We would like to hold the task force itself to a manageable number of around a dozen, mostly comprising the experimenters wrestling with this very difficult measurement, but with a well-rounded theorist as well. It is important that all groups feel represented and cannot consider that the task force is in any way prejudiced in favor of any group's current approach. We will consult with you about membership but we will take on the task of persuading them to help.

Our hoped timing for this task is aggressive but should be achievable. We would like to see the first task group meeting as soon as April, followed by a period of community input. We are prepared to support a workshop or conference if the TFCR feels this is the right approach, or any other method of reaching the necessary consensus. We then see the TFCR as meeting again in the fall of this year with the aim of writing a report, through the end of the year, to be delivered to the agencies in January 2005.

The implementation of your recommendations, concerning priorities, budgets, and division of tasks between the agencies, is then our responsibility, although we would welcome any advice the TFCR offers."

Since the above letter was written there has been a further request by NASA that the Task Force be able to provide a set of bullets for a December 5, 2004 meeting of the NASA advisory panel considering the "Structure and Evolution of the Universe".

MEETING DATES AND PLACES

The NSF has provided us with places to convene and some administrative and logistical support making it logical to locate the meetings at NSF Headquarters in Arlington, Virginia.

We will need four meetings (and efficient communication of drafts) to get our job done. The first meeting will be for two full days sometime between May 25 through June 3. Please send me times when you CANNOT make it during that interval.

The second meeting is on July 29 and 30, 2004.

To accommodate teaching faculty, the third meeting will take place over the weekend October 2 and 3, 2004 and the final meeting November 13 and 14, 2004.

The intent is to have a draft report ready to send to a set of external readers after the October meeting. Part of the November meeting would be dedicated to reviewing and incorporating their thoughts and comments.

The task force has a web site at

http://emvogil-3.mit.edu/~weiss/cmbpolarization/

PROCEDURES and PLANS FOR THE FIRST MEETING

The Task Force represents a subset of the people working in the CMB business and it is important that all good ideas are brought forward if we are to succeed in providing the agencies with a suggested road map for the research. We will concentrate on the CMB polarization but should not neglect the other active areas in CMB research and their associated technologies and problems. The intent is to have groups report to the Task Force on coherent and incoherent detector technology, Sunyaev/Zeldovich CMB spectral shift measurements, high spatial resolution anisotropy measurements and improved low frequency spectrum measurements.

We may also decide at our first meeting that it would be useful to listen to more theorists in addition to those represented on the Task Force.

I would like to ask the Principal Investigators (all are Task Force members) of the Einstein Probe CMB polarization proposals reviewed by NASA last year to prepare presentations on the proposals for the Task Force at our first meeting. The proposals were:

Experimental Probe of Inflationary Cosmology (EPIC), James Bock PI (JPL)

Einstein Polarization Interferometer for Cosmology (EPIC), Peter Timbie PI (Univ of Wisconsin)

Mission Concept Study for the Einstein Inflation Probe, Gary Hinshaw PI (GSFC)

The other business of the first meeting will be to iterate the draft outline of the report and to ask Task Force members to take special responsibility to lead the development of sections of the report.

Also at the first meeting we will decide which special groups on specific CMB topics it would be useful to hear at subsequent meetings.

SUBJECT OF THE OTHER MEETINGS

Clearly, we will decide this together at the first meeting but it seems certain that subsequent meetings will include reports from the special groups requested to give testimony to the Task Force and we will have extensive discussions of the report sections as they become formulated.

DRAFT OUTLINE OF THE TASK FORCE REPORT
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0. Executive summary (bullets) and an elegant figure showing polarization amplitude vs angular scale for a variety of theories, the spectra of various perturbations, the current state of measurements and the projection for a major mission.

1. Pedagogic description (in English) of what is a polarization in the CMB and simple pictures of how the polarization is generated

a) Cosmological significance of measuring the polarization

i) primeval cosmological potential fluctuations and dark matter
ii) primeval gravitational waves, their inscription on the polarization
iii) separation of the effects
iv) tests of inflationary models

b) The information in the spatial distribution of the polarization

c) Models and estimates for the polarization amplitudes (Stokes components?)

2. Perturbations and disturbing effects that could interfere with the measurements and their interpretation - their estimated (color) spectrum and angular scales

a) Fluctuations in propagation

i) gravitational lensing by intervening matter (gravitational scattering)
ii) Faraday rotation and intergalactic and interstellar magnetic fields (electron scattering)
iii) polarization selective scattering by dust oriented in magnetic fields (dust scattering)

b) anisotropies in the foreground polarized radiation

i) polarization in cosmic reionization
ii) Galactic synchrotron emission
iii) Galactic free-free emission
iv) Galactic polarized dust emission

3. Suggested measurements and observations to reduce the uncertainty in the estimates of the perturbations

a) Suggested observing programs to measure the polarized foregrounds

b) Observational methods to reduce the influence in a given CMB polarization map or observation, for example, direct lensing measurements along a specific line of sight.

4. Observational limits and values now known of the CMB polarization components at a variety of angular scales and frequencies (colors)

   a) Initial ground based experiments
   b) Balloon borne measurements
   c) COBE limits
   d) DASI measurements
   e) WMAP measurements

5. Prospects from on going experiments
   (RW does not know the experiments)
   a) sensitivity
   b) angular scales
   c) frequency coverage
   d) when results might be expected

NEW TECHNICAL DEVELOPMENTS AND EXPERIMENT DESIGNS AND STRATEGIES

6. Measurement sensitivity and multiplexing spatial and spectral coverage
   a) Prospects for improved detector sensitivity
   b) Development of arrays and multiplexers
   c) Low noise amplifiers
   d) Cryogenics

7. Optical design and technology development
   a) Lightweight mirror designs and radiation shields
   b) polarization modulators
   c) design for control of instrument polarization anisotropies
   d) coupling horns and single mode couplers

8. Experiment (observing) strategies and experiment modeling
   a) angular scales and scanning techniques
   b) spectral coverage needed to enable separation of foregrounds
   c) sky coverage required to separate perturbations and to allow separation of the intrinsic polarization sources

9. Control of systematics
   a) Polarization of back lobes and edge beams
   b) calibration of polarization anisotropies of the instrument
   c) stability of the instrument polarization anisotropies
   d) single beams or differential beams

10. Program to address the experimental issues and uncertainties, a time line
    a) ground based research
    b) balloon based research
    c) preliminary satellites? Explorer class
    d) value of component tests
    e) need for integrated tests
    f) need for actual measurement to determine the unforseen problems
    g) Can one recommend a specific Einstein probe mission?

11. Brief description of other research on the CMB
    a) Sunyaev/Zeldovich measurements
    b) Small spatial scale anisotropies
    c) Low frequency CMB spectrum measurements

SUGGESTED READERS

Experiment:

Chuck Bennett	GSFC
Steve Meyer	Chicago
Phil Lubin	UCSB
Anthony Readhead	Caltech
John Carlstrom	Chicago
Suzanne Stagg	Princeton
Bill Holzapfel	Berkeley
Amber Miller	Columbia
Greg Tucker	Brown
Ned Wright	UCLA

Theory:

David Spergel	Princeton
Wayne Hu	Chicago
Marc Kamionkowski	Caltech
Alan Guth	MIT