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Report from the SEUS

Chuck Dermer, Past Chair, Division of Astrophysics/American Physical Society, 2002

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Revised:

Structure and Evolution of the Universe Subcommittee meeting, February 27-28, 2003, Jet Propulsion Laboratory, Pasadena, California.

We still don't give advice to government, but rather we give recommendations to the SScAC. Professor Tom Prince (CalTech), now wearing chief scientist hat at JPL, welcomes us by noting the large amount of activities at JPL going on around SEUS and OS themes, for example GALEX and SIRTF, not to mention the extensive planetary exploration projects, including upcoming Mars rover missions. Dr. A. Kinney (NASA HQ) welcomed a joint OS/SEUS session. Prof. A. Dressler (CIW) is rotating off as chair of the ASO subcommittee, and Prof. D. Spergel (Princeton) will be assuming the OS chair. Dr. Kinney spoke about SIRTF, HST, GP-B, Beyond Einstein, and JWST. A final HST reservicing mission to install the Cosmic Origins Spectrograph will take place, and *Hubble* will be brought back by shuttle, even given the issues raised by the loss of the Colombia. Regarding GP-B, NASA is losing confidence to get the payload to the launch pad and to fly it successfully. Correcting failures in the thermal vac is crucial to mission success, and the flight delays are proving expensive. There is also a sense of erosion of science goals during the long delays (it took GP-B 39 months to get two months closer to launch). *Beyond Einstein* is an approved program and is in the President's FY04 budget. As presently configured, LISA will launch in 2011, and the Con-X launches are slated for 2013-2014. Money for Einstein probe development starts in FY07. There is 5 M$ R&A money in the *BE* program in the FY04 budget, ramping up to 12.4 M$ in FY08. Cost growth in the JWST from 500 M$ in 1996 to 1.6 B$ at present was discussed in light of de-scope options.

Dr. Dan Lester (U Texas, formerly a SEUS member) presented on SAFIR (pronounced 'sapphire,' a gem of a mission), a Single Aperture Far IR (30-300 micron) mission. The far IR-submm community has issued a white paper detailing a space-based far IR detector. The proposed mission will reach better than 10^{-16} ergs cm^{-2} s^{-1} sensitivity at 100 microns in a one-hour pointing. It is a follow-on to Herschel and SIRTF, suggested to be flown in the 2010-2020 time frame. The proposed mission has a 4 arc-minute field-of-view and 2.5 arc-second imaging at 100 microns. It does far IR science: IR line and dust diagnostics, buried sources, distinguishing starburst and hard photo-ionization spectra thought to be signatures of black hole accretion. It will make Herschel results obsolete. It

is a chemistry probe of the warm cosmos, and will map large pre-biotic molecules. As is stated in the handout "Dust is everywhere (eventually) – be not fooled …" It sounds more like OS science to me.

Dr. P. Crane (NASA HQ) presented on OSS Strategy. Code S (Office of Space Science) is obligated to release a Strategy for the 2003 Space Science Enterprise. Within the 'One NASA' are six enterprises (also including Earth Science, Biological and Physical Research, Aerospace Technology, Education, and Space Flight) to pursue 7 goals that realize three Mission Areas, namely, to Understand and protect our home planet; Explore the Universe and search for life; and Inspire the next generation of explorers. The goals cover the Earth system, aerospace transportation system, security, space-station science, educational, and public outreach activities. Code S must define goals and metrics to satisfy the GPRA (Government Performance and Results Act) by submitting a 5-year plan every three years. This meeting was an opportunity for members of SEUS and OS to check and correct strategy statements in the 2003 Space Science Enterprise Strategy, which is probably the best document to get a high-level summary of Space Science activities at NASA.

Dr. P. Hertz (NASA HQ) gave the SEUS theme update after the meeting broke up to return to parallel sessions. Operating missions in A&P (both OS and SEUS) are: HST, RXTE^{x}, 2MASS^{x}, SWAS^{x}, FUSE, CXO, XMM-Newton, HETE-2^{x}, WMAP, Integral, and CHIPS (launched Jan. 12, 2003). (^{x} refers to extended phase; all others are in their prime phase.) Except for two yellow months each for a FUSE reaction wheel anomaly and the loss of a proportional counter in HETE-2, all months were green. GALEX is scheduled for a March 25, 2003 launch. It had a yellow in December, but a green January and February. On the other hand, GP-B had a double row of red. GLAST had a yellow February because of DLR budget problems with the GBM. Paul updated us on the balloon program, which continues to limp along. There were ATIC and Boomerang missions in FY 2003. The situation between NASA and NSF is resolved by remaining unresolved: "NASA Buys, NSF Flies." There is a delay on the Russian side regarding arctic balloon overflight, which caused a postponement of June 2003 arctic balloon campaigns. *Beyond Einstein* is in the budget: the FY03-08 rollout (in M$) is: Con-X (18.9-89.3), LISA (9.7-141.5), Probes (15.0 in FY07-08), and R&A (5.0-12.4 for FY04-08). The TRIP (Techonolgy, Readiness, and Implementation) Review panel to assess the milestones and feasibility of Con-X and LISA meets March 4-7, and has site visits March 20 (Con-X) and April 1 (LISA). The review will be incorporated into mission planning and scheduling. NASA solicits mission concepts for the Einstein Probes (3 selections of ~1 M$/year for up to 2 years). The OSTP-led Interagency Working Group on Physics of the Universe has not yet decided whether to fund multi/other-universe studies.

Dr. Charles R. Lawrence (US Planck Project Scientist) reported on Planck, the 3rd Medium-Sized mission of ESA's Horizon 2000 Scientific Programme; launch for 2007 on an Ariane 5 rocket. It is a successor to COBE and WMAP and operates between 30 and 857 GHz. Simulations comparing Planck (1 year) and WMAP's (4 year) results show great advances in higher multipole (ell>700) and CMB polarization measurements. A

model distinguishing separate ionization histories of the Universe was claimed to be testable with Planck, which will also detect ~2000 radio sources, ~10^4 dusty galaxies, and ~10^4 galaxy clusters through the SZ effect. The only problem is: ASI withdrew support of the 100 GHz channel on LFI, the loss of which would seriously compromise Planck science.

We also heard from Dr. Harold Yorke (JPL; also a SEUS member) on Herschel, the ESA Cornerstone Far-IR/sub-mm 2007-2012 mission, which consists of two instruments that span the 60-670 microns range, and HIFI, a heterodyne instrument at 480-1250 GHz and 1410-1910 GHz. This mission will, as for SAFIR, probe distant dusty galaxies. It will make galactic maps at the 158 micron CII coolant line, and investigate photo-dissociation regions near OB stars. The importance of OB stars was stressed, though I have my doubts that "Turbulence from OB stars … accelerates cosmic rays." There is still opportunity for cost growth and schedule slip in this mission. The spider-web bolometers are kept at 0.3 K, and kevlar was used to attach the photometer structure to the cryostat. Kevlar shows hysteresis during thermal cycling: "Kevlar: the lessons learned."

Later that afternoon, we were briefed by Dr. E. Fomalont about possible NASA participation in RadioAstron, a Russian Space VLBI project that would cost NASA ~12 M$ (FY 03-09), assuming a FY06 launch. There was some consideration about contracts with exit clauses in case technical risk of failure became unacceptable. The background of RadioAstron is that it would chart radio emissions at 1.5 microarcsecond resolution, and observe in a range of frequencies (0.3, 1.6, 5, and 22 GHz), but only for sources brighter than 0.5 Janskys. Cen A and M87 were candidate targets to probe on the Schwarzschild scale. Further background is the loss of a 22 GHz waveguide in VSOP, so that RadioAstron would have a small window (depending on future progress of VSOP-2) to make some discoveries. It would be a very powerful probe of the inner regions near a black hole. Technical and programmatic issues regarding RadioAstron were addressed by Dr. J. Hayes (NASA HQ). Dr. Ken Kellerman (NRAO) was in the audience and weighed in on the discussion. There were claimed to be 30 or so good extragalactic targets, though no source list was shown. Participation in this project might compromise future development efforts or partnering opportunities by US space VLBI scientists. In the end, the SEUS did not recommend to support this mission.

Dr. Edward Weiler (NASA HQ) gave us our next morning wake-up call. Beware the bearer of good news. The four-year OSS Budget run-outs from FY 2000 are all positive definite. The five themes split the OSS FY04 budget according to the following percentages: SEU, 11%; SEC, 19%; ASO, 22%; SSE, 34%; Mars Exploration, 14%, with a normalization of 431.6 M$ for SEU. Space Science is slated to grow by 60% over the next 5 years. There are three new initiatives in the past year. The first is JIMO, the Jupiter Icy Moons Orbiter, for which Project Prometheus is JIMO's first program. Prometheus supersedes the Nuclear Systems Initiative, and provides 250-500 kW (!) of spacecraft power. A design driver is just dumping the heat. The second initiative is the

establishment of an Optical Communications program utilizing adaptive optics. Optical com will make radio communications obsolete in 10-20 years. It will provide 10 Mbps (n.b.: Dr. Weiler said 10 MBps, the doc says 10 Mbps) data transfer rate. Instead of using a data relay satellite, tethered balloons at 70-80,000 feet would be used. The third is *Beyond Einstein*.

A GALEX UV explorer is to be launched by a Pegasus on March 25, 2003 from Cape Canaveral. Such observations will tell galaxies how scientists change and evolve, and vice versa. SIRTF is scheduled to launch April 15th of this year from the Cape on a Delta II Heavy. Delta-IIs will launch two Mars Exploration Rovers from the Cape on May 30th and June 25th. I asked about the science of the debris field realized by the Colombia tragedy, and if it would have any operational impact. Most missions fly out of LEO these days, and the engineers are checking their models. I had another chance to talk with Professor Adam Burrows (Arizona) about the succession of events leading up to the collapse of a stellar core to a neutron star or black hole. I asked whether SN light curves could be derived analytically, which is a problem I am struggling with to answer a referee's report: "It depends on how low your standards are." A NASA official who happened to overhear us stated: "Sounds like a comment you'd hear at headquarters."

The later parts of the morning were taken up with drafting a letter, and learning more about LISA science and SEUS activities at JPL. I left before the tour of the JPL facilities (by invitation only; mine didn't come in time).

For the high-energy community, it might be worth noting that a medium-energy (MeV) gamma-ray workshop with the development and release of a white paper and a consensus on some single overarching mission design—including a fact sheet— will be required to consider a mission for pre-Phase A or development studies. Now that INTEGRAL has launched, it is imperative to develop a concept for an MeV line telescope with 10-100 times better sensitivity than CGRO and INTEGRAL. Let's talk about MeV telescopes in Philadelphia; I have some ideas too. See you there.

Report from the SEUS

Chuck Dermer, Past Chair, DAP/APS 2002

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Structure and Evolution of the Universe Subcommittee meeting, December 3-4, 2002, NASA Headquarters.

At the time of the meeting, the SEUS is in the process of being rechartered as a FACA committee, so we are technically not an Advisory Council to NASA. Thus we make suggestions rather than recommendations. Professor E. Kolb (Fermilab) is the chair of and Dr. Paul Hertz is official NASA representative of the SEUS. Dr. A. Kinney represents Astronomy and Physics in Code S (Office of Space Science) at NASA. A&P includes ASO (Origins Subcommittee) and the SEUS. Dr. Phillipe Crane is the NASA OS official. Dr. Kinney reports to Associate Administrator E. Weiler, head of Code S, who reports to the NASA Administrator Sean O'Keefe.

During the morning and early afternoon of the first day we had a joint committee with ASO. First on the agenda was a director's report from Dr. Kinney: after the UNEX Chips launch on Dec. 19th, 2002, the UNEX program is phased out. GALEX launches in March 2003. There is a slip for SIRTF to April 2003, and a slip for GP-B to July 2003 due to a thermal vac problem. The final Hubble reservicing mission is scheduled for '05, to give it a full set of gyros and two new instruments. A virtual National Astrobiology Institute is funded by NASA and NSF. There has also been a proposal for a National Origins Institute. There was some discussion about the end of *Hubble*: space debris, a fiery death, fling it into deep space, or retrieve it. I favor the latter.

We got updates from Professor Allen Dressler about the Origins Roadmap, and from Professor Rocky Kolb about the SEUS Roadmap. They are both amazing documents, and I invite you to examine them for the richness of the science and their intellectual depth. The Roadmaps will be available in their final form at the Seattle AAS. Professor S. Phinney (CalTech) chaired the SEUS roadmap committee. The cosmic quest is to go Beyond Einstein, determine how the universe began, if time has an end, if space has edges; to ask what dark energy is, what powers the big bang, and what happens at the edge of a black hole. A gravitational wave detector (LISA) and exquisitely sensitive X-ray telescope (Con-X—though with only modest angular resolution) are proposed to answer these questions.

Professors Doug Richstone (U. Michigan) and Joel Bregman (U. Michigan) presented on the Astronomy and Physics Working Group and the Space Archives Working Group, respectively. The R&A program supports these groups. Some of the APWG issues are Laboratory Astrophysics, financial support for scientific meetings, the Technology Readiness Level gap and working with Code R (Aerospace Technology). TRL levels 3-6 are only supported by flagship missions, but not in the Explorer program. The SAWG handles archiving, the National Virtual Observatory, ADS, NED, HEASARC, NSSDC, CDS, etc.

There was a report on the National Astronomy and Astrophysics Advisory Committee (NAAAC; the "knack") by Dr. Abi Saha (NOAO). The charge to this panel is to evaluate the effectiveness of interagency cooperation between NSF Astronomy and NASA. Some current and past joint NSF and NASA efforts are 2MASS, IRTF support, the Antarctic meteorite program, the Sloan Digital Sky Survey, and the Antarctic sub-orbital Balloon Program. In view of recommendations of projects by the Taylor-McKee report, some future collaborative projects might be the Large Synoptic Survey Telescope, the National

Virtual Observatory, the James Webb Space Telescope, and the Giant Segmented Mirror Telescope. There is a difference in culture between NASA and NSF. One of the NAAAC's recommendations is for NSF Astronomy to have an advisory structure similar to NASA's.

The major programmatic issue that occupied much of this meeting was the balloon program. Dr.Vernon Jones (NASA HQ) and Dr. Dennis Peacock (NSF) presented the issues that confronted their agencies. Professor Simon Swordy (U Chicago) gave a presentation on balloon science (including gamma-ray, cosmic ray, CMBR, and auroral science), and Dr. Steve Smith (NASA/GSFC) presented on ultra-long (~100 day) duration ballooning. ULDB in Antarctica has much in its favor, although the radiation environment is very intense. I am in favor of having a workshop on this topic, as it cannot be fairly summarized here. The crux of the matter is that NSF is providing servicing and support for the NASA sub-orbital balloon program, but deterioration of the facilities and unexpected maintenance costs are tasking NSF beyond what they feel obliged to contribute, which obligations date back to a Memorandum of Understanding signed 8/22/88.

This issue came up a few years ago, and I was opposed to transferring NSF's involvement of the Antarctic Balloon Program to NASA (and the associated costs, which amount to about a five year run-out of 5-10 M$). I have changed my mind after this meeting. I think that NASA should have a vigorous balloon program, which is not limited by program constraints of other agencies. I view this 5-10 M$ figure in the context of the change in the cost caps to the SMEX program, as reported by Dr. Hertz. There will be fewer SMEX's because the cost cap is being raised from about 80 M$ to 100-120 M$. This is in recognition of the realities of increased costs for light boosters, and the uncertain availability of the Orbital Pegasus and the phasing out of the Delta-II by Boeing. There is no more money in the Explorer program. Simon Swordy argues that augmenting and supporting a vigorous balloon program can train a larger cadre of hardware-savvy graduate students and space scientists, to which I agree. This is also in light of the costs of the costs of IceCube, a major high-energy neutrino project at the quarter billion dollar level over which NSF has primary responsibility.

Also discussed at this meeting are issues of debriefing, debrief information availability, review and appeal processes, the phasing out of the junior/senior distinction in the LTSA/ADP categories (a mistake, I think), and I had a brief moment to chat with Adam Burrows about core collapse supernovae and the collapsar model.

We had talks on INTEGRAL by Bonnard Teegarden (GSFC), Astro-E2 by Rich Kelley (GSFC), and SPIDR by S. Chakrabarti (Boston U.). I saw my first INTEGRAL data, and am looking forward to much much more. Great science coming up! See you in Philadelphia.