regard to the search for baryonic dark matter in the form of brown dwarfs. One possible way out of this dichotomy between theory and observation would be to find a physical mechanism for severely attenuating the low mass end of the IMF. This research was supported by NSF Grants AST-90-14479 & AST-90-22501.

12.02

The Chemical Composition of Very Strong Lined Giants
R. Earle Luck and Sharon L. Challener (Case Western Reserve University and Allegheny College)

Stellar parameters and abundances for a sample of 55 G/K field giants of which 22 are normal stars and the other 33 are classified as VLSI have been determined based on high-resolution - high signal-to-noise KPNO coude spectra. The primary pertinent points of comparison between these stars are: 1) VLSI stars have [Fe/H] ratios that average +0.1 dex relative to normal giants; 2) VLSI stars are modestly carbon and nitrogen rich relative to the normal stars. The mean difference in [C/Fe] is +0.1 and for [N/Fe] is +0.05; 3) The [O/Fe] ratios of the normal and VLSI stars are comparable; and 4) The lithium abundances: 12C13C ratios, and [Fe/Fe] ratios for Z > 10 are comparable in the two groups. The combination of the first through third points is sufficient to explain the difference in VLSI and normal G/K giant spectra.

Our preferred interpretation of the VLSI stars is that they are the result of normal evolution of a dwarf whose initial composition is somewhat metal-and carbon-rich. The fraction of stars with these properties is consistent with the number of VLSI giants.

12.03

The UV-Bright Stars of Omega Centauri
W.B. Landsman (HSTX/GSFC/LASP), A. Crotts (Columbia Univ.), R.W.O. Connell, J.H. Whitney (UVa), T. Lanz (USRA/GSFC/LASP), T.P. Stecher (NASA/LSFC/LASP)

Images of the globular cluster Omega Centauri obtained with the Ultraviolet Imaging Telescope (UIT) in 1990 revealed numerous hot stars more luminous than zero-age horizontal branch (Whitney et al. 1994, AJ, 108, 1535). We have obtained CTIO 4m and IUE low-dispersion spectra of seven of the brightest stars in the Whitney et al. catalog. The target stars include UIT-1 and UIT-2 in the core of Omega Cen (Landsman et al. 1992 ApJL, 395, L21), as well as ROA 5342, Dk 3873, and Dk 3089 from the catalog of Dickens (1988).

All of the target stars are found to be radial velocity members of the cluster. Three of the stars (ROA 5342, UIT-151, Dk 3873) show strong He II lines in their spectra and are probably very hot (> 20,000 K) post-AGB stars. The remaining four stars show strong He I lines, and UIT-1 also shows numerous nitrogen lines. We present results of an atmospheric analysis to constrain the reddening, effective temperatures, and helium abundances.

12.04

The Effect of Velocity Gradients on Cepheid Spectra: Velocities, asymmetries, and Baeade-Wessendoza Determinations
R.P. Butler (U.C. Berkeley), R.A. Bell (University of Maryland), R.B. Hindley (U.S. Naval Observatory)

Synthetic spectra have been calculated from model hydrostatic stellar atmospheres using physical parameters (effective temperature, abundances, etc.) appropriate for Cepheids. Velocity gradients have been kinematically introduced in order to study their effect on line profile asymmetries and radial velocity curves. The results are compared to high resolution observations of η Aql.

It is shown that a significant velocity gradient is needed near the phase of maximum infall velocity to account for observed line profile asymmetries and velocity differences of absorption lines from atoms of different ionization and excitation. The effect of this velocity gradient is to reduce the amplitude of the pulsation velocity curve at optical depthτ = 2/3 by 20% and to decrease the γ velocity by 2 km/sec relative to the standard Barnes-Evans or Baade-Wesselink assumption of a co-moving atmosphere.

Barnes-Evans calculations of η Aql have been made taking velocity gradients into account. The resulting size and distance of η Aql is reduced by about 17%.

12.05

The P-L Relation and Cepheid Evolution
N.R. Simon, T.S. Young (Univ. Nebraska-Lincoln)

We construct a large number of linear pulsation models spanning the parameter space suggested by various Cepheid evolution tracks. These models give rise to period-luminosity (P-L) relations which vary according to the specifics of the evolutionary track selected. Thus uncertainties in the evolution calculation result in uncertainties in the P-L relation and therefore in the distances inferred to external galaxies. In the present work, we attempt both to estimate these uncertainties and, reversing the question, to ascertain to what extent observed P-L relations can constrain the Cepheid evolution tracks. We shall see that substantial work remains to be done before a clear picture emerges of Population I Cepheid evolution.

12.06

The Luminosities of RR Lyrae Stars
D.H. McNamara (Brigham Young University)

The new Kurucz model atmospheres indicate that the temperatures of RR Lyrae stars inferred from optical and near infrared color indices are approximately 200°C to 300°C hotter than those inferred from older models. If these temperatures are adopted we find the absolute magnitudes of the RR Lyrae stars are 0.2 mg brighter than previously assumed.

If we adopt the new magnitude scale we find:
1) the ages of globular clusters are reduced 2) the distance to the galactic center is increased, and 3) the RR Lyrae stars give distances to local group galaxies identical to distances inferred from classical cepheids.

Session 13: Solar System
Oral Session, 10:00am - 11:30am
Westmoreland

13.01

Analysis of Japanese observations of the Martian Polar Caps
B.L. Lindner (University of Charleston, SC), K. Iwasaki (Kyoto Gakuen University, Japan), T. Akabune (Hida Observatory, University of Kyoto, Japan)

For over 20 years, the seasonal regression of the martian polar caps has been regularly observed from the Hida and Kwasan Observatories in Japan and the Boscha Observatory in Indonesia (e.g., Iwasaki et al., J. Geophys. Res., 95, 14751, 1990). Some of the interesting features which have been observed include a temporary halt observed in the regression of the north polar cap; observed variations in the regression of both polar caps with longitude; and isolated outliers of ice such as the Mountains of Mitchell. Simulations of the regression of the martian polar caps obtained via a complex energy balance computer model (e.g., Lindner, J. Geophys. Res., 98, 3339, 1993) have been compared to the dataset. We find that variations in terrain and surface roughness can easily account for these interesting fea-
HST Astrometry of the Uranian Inner Satellite System

D. Pascu, J.R. Rohde, P.K. Seidelmann (USNO), D.G. Currie, D.M. Dowling (UMd), E. Wells, C. Kowal (CSC/STScI), B. Zellner (GSU), A. Storrs (StScI)

The ten faint, inner satellites of Uranus have not been observed since their discovery in 1986 with Voyager II. Astrometric observations of these faint satellites with the Hubble Space Telescope were sought in an effort to improve their orbits for a spectroscopic follow-up and to study their dynamical resonances.

Thirty three images were taken on August 14, 1994 with WFPC2 in the BVRI filters. As expected, eight of the ten inner satellites were recovered only the two faintest and innermost were not detected. In addition, measurable images of Ariel and Miranda were obtained on the same CCD chip. The orbits were well covered, and a range of exposures was used to cover the nine magnitude difference between Ariel (V=14) and Bianca (V=23).

Our strategy was to use accurate Miranda/Ariel orbital predictions and measurements to reduce the measurements of the faint satellites. We will discuss in some detail our techniques of measurement and reduction, as well as our results. While measurement precision varied widely depending on signal strength, even rough pixel measurements have a precision of 0.04 arcsec in the Planetary Camera.

In addition to astrometry of the faint satellites, the four color images were used to determine magnitudes and color indexes for the brighter ones, relative to ground-based photometry of Ariel.

An Exhaustive Search for Stable Orbits between the Outer Planets


Using high-order multistep integration methods optimized to minimize roundoff error propagation, we performed fully three-dimensional integrations of planetesimal trajectories for 100 million years to examine possible niches in the Jupiter/Saturn, Saturn/Uranus, and Uranus/Neptune zones. We computed the trajectories of 100,000 massless particles in the Jupiter/Saturn zone, and 10,000 particles each in the Saturn/Uranus and Uranus/Neptune zones. A planetesimal situated between two large perturbers resides near a separatrix that determines the qualitative dynamical character of its orbit. Given sufficient time and according to the accuracy of the scheme, the dynamical character will artificially change in the vicinity of a separatrix. The modified Cowell-Störmer integrator employed in these surveys produces a longitude error for Jupiter bounded below 2° in 1 billion years, orders of magnitude smaller than earlier surveys. Other surveys, particularly those based on mapping techniques, sacrificed numerical accuracy in order to permit greater integration times. We believe that this may have resulted in an incorrect assessment of the relative significance of the different physical ejection mechanisms present.

The highly accurate integration of such large numbers of particles (i.e. employing hundreds to thousands of times more particles than in previous surveys) allows us to make statistically significant inferences about the dynamics and dominant physical mechanisms in these regions. Sample sizes should be at least 10,000 so that the "statistics of small numbers" is not a factor. In assessing the reliability of such "counting experiments," the relative error (i.e. 3σ level) is on the order of 3/√N for a sample of size N—for a survey containing 100,000 particles, this is 1% of the sample; for 100, particles, counts with fewer than 30% the sample are not significant. The very large size of our samples, coupled to the increased numerical accuracy in our surveys permits us for the first time to explore the relative significance of the various ejection mechanisms present.

Mappings and Integrators on the Edge of Chaos

W.I. Newman, F. Varadi, K.R. Grazier, W.M. Kaula (UCLA)

The relationship between symplectic properties and numerical accuracy is investigated using the dynamics of the Jovian planets as an example. What are the properties of symplectic integrators, including both their benefits and limitations, and how do they contrast with classical integration schemes? The dynamics of the Wisdom-Holman mapping appears to be different than that provided by very high order multistep integrators. We will clarify the nature of such differences and how they affect orbital trajectories using elementary results in bifurcation theory. The significance of these differences regarding chaotic dynamics in the Solar system is discussed. Can the distortion of the dynamics by the Wisdom-Holman mapping lead to artificial separations and separatrix crossings—and to incorrect physical conclusions regarding the dynamics?

The Astrophysical Journal: A New Journal for a New Science

R.S. Brashear (Huntington Library)

The emergence of astrophysics as a discipline is of great significance to the history of modern astronomy. The late nineteenth century saw astrophysicists struggling to be taken seriously by classical astronomers. This paper looks at a key development in the professionalization of astrophysics: the introduction of the Astrophysical Journal and its connection to the rise of astrophysics. The Astrophysical Journal was the most important of the new publications that acted as a clearinghouse for articles on astrophysics and laboratory spectroscopy. Of greater consequence, however, was the new journal's representation of the status of astrophysics within the larger realms of astronomy and science in general.

The Astrophysical Journal Centennial

D.E. Osterbrock (UCO/Lick/UCSC)

A brief history of the Astrophysical Journal is given, concentrating on its beginnings, its predecessor and rival journals, the astrophysicists who founded it, and the growth and development of astrophysics in the century since then. Later stages in the Journal's history are related, in less detail, down to the present. Some of the first papers in new fields, such as radio astronomy, balloon astronomy, space astronomy, and X-ray astronomy are mentioned. A few of the financial crises are described, as well as one or two attempts to undercut the Journal.

Slides of all the managing editors: George Ellery Hale (1895-1904), Edwin B. Frost (1905-32), Otto Struve (1932-47), William W. Morgan (1947-52), S. Chandrasekhar (1952-71), and Helmut A. Abt (1971-) will be shown. Slides of other editors, including Benjamin A. Gould (Astrophysical Journal), William W. Payne (Sidereal Messenger), Edward S. Holden (PASP), and W. W. Campbell (Lick Observatory Bulletins) will also be shown, and their publications discussed.
Some Highlights of the Astrophysical Journal

Helmut A. Abt (NOAO/KPNO)

We first name some prominent authors during the first 25 volumes. Then we list the major changes made in the Journal during the past 100 years. The authors with the longest publication records are listed, as well as the most prolific ones before 1944 and other such records. Finally based on counts of papers and pages published annually, we found that the sudden growth of astrophysics did not occur after World War II or after Sputnik, but at a financially disadvantageous time that will surprise you.

Session 15: AGNs II: Models
Oral Session, 2:00pm - 3:30pm
Allegheny I II

15.01
On the Beaming Statistics of Gamma-ray Sources
Charles D. Dermer (E. O. Hulburt Center for Space Research, Code 7653, Naval Research Laboratory, Washington, DC 20375-5352)

The beaming pattern produced by a relativistically moving blob of isotropic nonthermal electrons that Thomson-scatter photons from an external isotropic radiation field goes as $D \propto r^{-2}$. Here $D$ is the Doppler factor and $r$ is the energy spectral index of the radiation. This differs from the well-known beaming pattern produced by radiation emitted isotropically in the blob frame, which is $\propto r^{-3}$ This result is important for treatments of blazar statistics, beaming constraints, and tests of gamma-ray source models.

15.02
The Origin of Powerful Radio Sources
A. S. Wilson, E. J. M. Colbert (UMD & STScI)

Radio-loud active galaxies are associated with elliptical or elliptical-like galaxies, many of which appear to be the result of a recent merger. In contrast, radio-quiet active galaxies prefer spiral hosts. Despite the very large difference in radio luminosities between the two classes, their continua and line spectra from infrared through X-ray frequencies are very similar. In this paper, we describe recent developments of our model (Ap. J. 438, 62 1995) in which the radio-loud phenomenon is the result of a merger of two galaxies, with each galaxy nucleus containing a slowly (or non-) rotating supermassive black hole. It is envisaged that the two black holes eventually coalesce. For the small fraction of mergers in which the two holes are both massive and of comparable mass, a rapidly-spinning, high-mass hole results. The spin energy of a rapidly rotating $10^8$ solar mass hole suffices to provide the $\sim 10^{44}$ ergs in relativistic particles and magnetic fields of the most energetic radio sources. Luminous radio-quiet active galaxies contain high-mass, slowly-rotating holes, with the infrared through X-ray emission of both classes being fuelled by accretion as commonly assumed. We discuss constraints on the model from the luminosity functions of radio-loud and radio-quiet galaxies and from the known cosmological evolution of the radio source population; this evolution is assumed to reflect higher galaxy merger rates in the past.

15.03
The Synchrotron Self-absorbed Spectrum of a Spherically Accreting Nuclear Radio Source

I consider a scenario in which stellar winds within the dense stellar nucleus are intercepted by the dormant massive black hole (BH) sitting at the galactic center, and quasi-spherical accretion of the wind onto the BH occurs resulting in acceleration of relativistic electrons to produce the spectrum $N(\gamma) \propto \gamma^{-p}$. Under assumption on equipartition between the local energy density of the magnetic field and that of relativistic electrons, the spectrum of synchrotron radio emission is derived to be $\alpha=(13+2p)/(22+5p)$. It ranges between $\alpha=0.51$ to $0.56$ for the range of $p=3$ to $1$. The radius of the source is predicted to vary with frequency as $r \propto \nu^{m}$, where $m=-4(4+p)/(22+5p) \approx -0.7$; the higher the frequency, the more inner parts of the source are seen. Since at radii $r<r_{\nu}$ the radiation losses time becomes shorter than the inflow time, the spectrum is expected to have a cut-off at frequencies $\nu \gg \nu_{\epsilon}$. Inverse Compton emission offers additional tests of this model in the X-ray energy range. Two different states of accretion, a "low" and a "high," depending on the accretion rate $\dot{M}$, are discussed to predict the variability patterns.

This model is applicable to nuclear radio sources in the nuclei of nearby spiral galaxies such as M 81, M 104, etc., which have revealed the presence of a central compact radio source whose prototype in the Milky Way galaxy is Sgr A*. Similarly, in many early-type galaxies, parsec-scale radio cores have been found. The most important common feature of these sources is the inverted radio spectrum $\nu \propto \alpha$ with $\alpha=+0.3$ to $+0.5$, which is consistent with the above model. The observed radio spectra enable us to evaluate some important physical parameters of the accreting sources.

15.04
A Model for the NGC 6251 Jet
Theo Koupelis (UWMC)

The jet in NGC 6251 exhibits several stages of confinement and reexpansion, clearly indicating the role that the magnetic field of the jet and the thermal pressure of a hot gaseous halo associated with NGC 6251 play in the jet's evolution. The jet's "radius" is obtained from the observations up to a distance of 240 arcsec from the core. We apply to this jet a quasi-one-dimensional MID model in which the radius as a function of distance is given by the high-resolution VLA observations of Perley, Bridge, and Willis (1984). This, along with Einstein observations of NGC 6251 and X-ray halos of other elliptical galaxies, allows us to self-consistently examine the values of the jet velocity, density, magnetic field strength, and pressure distribution in the surrounding environment along the entire length of the jet. We compare our results to ones obtained by different theoretical models.

This research was supported by NSF grant AST-9318745 which we gratefully acknowledge.

Session 16: Astro 2
Oral Session, 2:00pm - 3:30pm
Allegheny III

16.01
The Astro-2 Ultraviolet Mission
Charles Meegan, John Horack (Marshall Space Flight Center), Arthur Davidson (Johns Hopkins University), Theodore Stecher (Goddard Space Flight Center), Arthur Code (University of Wisconsin)

The Astro-2 payload comprises three co-aligned telescopes that provide images, spectra, and polarimetry in the near and far UV. A total of 333 successful observations of 236 targets were obtained on a 16 day flight of the Space Shuttle Endeavour in March 1995. The altitude was 190 nautical
16.02

Results from the Ultraviolet Imaging Telescope on the Astro-2 Mission
T.P. Stecher (GSFC/LASP), R.C. Bohlin (STScI), S.G. Neff (GSFC/LASP), R.W. O’Connell (UVa), M.R. Roberts (NRAO), A.M. Smith (GSFC/LASP)

The solar-blind UIT camera with a CsI cathode obtained 722 frames with a cumulative exposure time of 260705 seconds during the March 1995 Astro-2 mission of Space Shuttle Endeavour. Filters were used to isolate selected bandpasses in the range 1200-1800Å, over the 40 arcmin field of view. Spatial resolution on most of the images is about 3 arcsec. Calibrated data, converted to machine-readable form, are under analysis and several posters on these investigations are presented in the Astro-2 poster session at this meeting (a first look at the UIT observations of Omega Cen, M31, and the Cygnus Loop is further elaborated here). UIT imaging of 20 spiral galaxies was obtained as part of a Guest Investigator program (Wendy Freedman et al.). UV imaging suppresses the red stellar population as expected and enhances the appearance of tracers of recent star formation. Known Hi regions in these galaxies are made apparent through the scattering of stellar ultraviolet light by interstellar dust; typically their shapes differ from those seen in Hα. A radial color gradient investigation will be delayed until ground observations can be made as the long-wavelength camera failed on launch and only the 1520 Å and 1620 Å images were made. The far-UV (1520Å) features are detected well beyond the Holmberg radius. UV/visible color-magnitude diagrams will be made as they were for the data from Astro-1. Our deepest images of the Magellanic Clouds reveal a rich field of luminous clusters and stars that are being searched for UV counterparts of the known X-ray sources in the photographed areas. The observed stars in the Clouds will be used to determine the current mass function. The respective contributions of nebular and stellar UV light in reflection nebulae are well studied as several nebulae were observed with differing geometries and will provide interesting results on the far-UV albedo and phase function of nebular dust. A dozen globular and open clusters were imaged.

16.03

Far-ultraviolet Images of the Moon from UIT
R. Gladstone, C. Na, A. Stern (SwRI), B. Buratti (JPL), T. Stecher, S. Neff, A. Smith (GSFC), R. Bohlin (STScI), R. O’Connell (UVa), M. Roberts (NRAO), R. Cornett, J. Offenberg, W. Waller (Hughes STX), UIT Team (GSFC; Hughes STX), Astro-2 Team (NASA)

We present the first far-ultraviolet (FUV) images of the Moon, obtained using the Ultraviolet Imaging Telescope (UIT) during the Astro-2 Spacelab mission in March, 1995. The data set comprises images taken at three phase angles (3.7°, 33.8°, and 57.4°), through three FUV filters (B6: 130–170 nm, B1: 135–170 nm, and B5: 150–175 nm), for four exposure times each (ranging from 1.3s for the shortest full Moon B1 exposure to 10s for the longest 57.4°-phase B5 exposure). Although a very difficult target to track (due to the combined 0.5%/s proper motion of the Moon and the 0.4%/s parallax motion from the sunlight), the apparent resolution of the images is 5 arcmin, or about 10 km on the lunar surface. Since UV emissions from the Moon are due entirely to reflected sunlight, the FUV images will provide very useful data on the ultraviolet scattering properties of lunar soils as a function of phase angle. In addition, these images will be used to examine FUV/visible albedo variations as a function of surface type (e.g., mare versus highlands), 2) test the hypothesis that FUV albedo is diagnostic of surface weathering exposure age (materials exposed to space tend to darken more quickly at UV wavelengths than at visible and longer wavelengths), and 3) provide "ground-truth" FUV data for comparison with future UV images of asteroids, planetary satellites, and other atmosphereless solar system bodies.

Progress in these areas will be presented at the meeting. We would like to acknowledge the excellent job done by the team of engineers, scientists, and astronauts in charge of pointing, and NASA's Astro-2 Guest Investigator project for support.

Session 17: Instrumentation, Techniques and Surveys

Oral Session, 2:00pm - 3:30pm

Westmoreland

17.01

The Advanced Camera for the Hubble Space Telescope

The JHU and Ball Aerospace Advanced Camera for the HST will have a high throughput, wide field (200′×200′), optical and I-band camera which is critically sampled at 1000 nm, a high resolution optical and near-UV camera critically sampled at 500 nm, and a high throughput, far-UV camera.

The AC's survey capability will be optimized for optical and NIR studies of the early Universe. The optimization is achieved by combining a novel, three-mirror optical design for the wide field camera with high reflectivity optical and NIR mirror and window coatings, a large format CCD optimized for the NIR, and a camera orientation chosen to minimize the time required to move to an adjacent field and begin a new exposure. The AC will increase HST's capability for surveys and discovery in the NIR by at least a factor of 10.

We will use ~ 350 CVZ orbits to take contiguous deep V- and I-band WFC images of 0.7 square degrees of sky to investigate the formation and evolution of galaxies and clusters of galaxies, and the nature and large scale distribution of dark matter. In the second survey, we will use Surface Brightness Fluctuations in deep WFC I-band images of early type galaxies to map large scale flow. We will use narrow band and polarimetric HRC and WFC images to address QSOs and AGN's, our second major science area.

The cornerstone of our approach to building the AC within the cost and schedule constraints set out in the NASA AO is reliance on STIS design and technology. The detectors and electronics for the far-UV and high resolution cameras are STIS design, and, in fact, may be STIS flight spares. Approximately 80% of the AC electronics modules and mechanisms are "build to print" from STIS drawings.

17.02

MARGIE – A Balloon-Borne Instrument for High Angular Resolution Hard X-Ray Astronomy

MARGIE (Minute-of-Arc Resolution Gamma ray Imaging Experiment) will be a new balloon-borne telescope to observe 30 - 300 keV gamma ray sources with excellent angular resolution (1′prime). The instrument will use a coded aperture mask and a fine-grained position-sensitive central detector. The mask will be 0.5 mm thick tungsten, with 0.5 mm pixels at a distance of 1.5 m from the central detector, giving an angular resolution of 1′prime and a fully coded field of view of 12′circ. The central detector will
17.03

A Schmidt Plate Magnitude Term

L. G. Taff (JHU), J. E. Morrison (STScI), S. Rösner (Astronomisches Rechen-Institut), B. M. Lasker, R. L. Smart (STScI)

Astrometry from fast wide-field Schmidt telescopes is complicated by complex structures that are not well represented by traditional plate-modeling polynomials. For stars at the average magnitude of the reference catalog, approximately \( V = 9.5 \) mag, these may be removed by any one of a number of modern techniques, eg. masks, sub-plates, or filters. The results of these new methods have, for the first time, allowed one to appreciate the true quality of stellar positions obtained from the large, fast Schmidt telescopes; even below the level of the 0.5 mag position-only dependent biases. A combination of these techniques has been used to construct version 1.2 of the Guide Star Catalog (GSC). Using data from the plate collection of the GSC, re-reduced with such techniques, we show that there exist large amplitude systematic errors which are a function of magnitude and radial distance from the plate-center. (Previous attempts to detect this effect were unsuccessful because they were less well-conceived, particularly with respect to the confounding effects of the plate-based systematics and to the use of leverage provided by the fainter stars.) The newly characterized magnitude effect is small for radii less than 2.5 deg from the plate center, then increases outward. The average offset of the faint stars at \( V = 15 \) mag versus the reference stars at \( V = 10 \) mag is 0.35, while at the corners the offset reaches 0.6. In the GSC plate material, the effect occurs both on the Palomar and UK Schmidt plates. The size and shape of the magnitude effect differs slightly between them. Thus, the effect, for the GSC plate data, is relatively independent of telescope, emulsion, passband, and to some degree, exposure depth.

17.04

Synthesized N-Point Chopping Pattern Analysis of the Python Data


We report initial results from a new analysis method for data taken with the Python microwave background anisotropy experiment.

The Python telescope performs a three-beam chop on the sky at multiple azimuth positions. The original analysis involved subtracting neighboring pairs of three-beam observations to produce a four-beam pattern on the sky.

This talk generalizes the original analysis in three ways and presents preliminary results of a reanalysis of the previous Python data.

First, we decompose the three-beam chop data into four independent modes. Two of these are signal modes which contain information from the sky. The other two are dark modes which have zero response to signals on the sky but non-zero response to instrumental effects.

Second, we allow more general methods of combining three-point observations (at neighboring azimuth positions and/or from independent detectors) to produce synthesized n-point chopping patterns.

Third, we synthesize n-beam chopping patterns which constitute optimal filters for estimating cosmological parameters.

This work was supported by the National Science Foundation under a cooperative agreement with the Center for Astrophysical Research in Antarctica (CARA), grant number NSF OPP 89-20223, M.D.'s PYI grant NSF AST 90-57089, and the James S. McDonnell Foundation. CARA is a National Science Foundation Science and Technology Center.

17.05

VLBI Determinations of Pulsar Parallax, Proper Motion, and Position

R.M. Campbell (Harvard University), N. Bartel (York University), I.I. Shapiro (Harvard University)

Interleaved VLBI phase-delay observations of two sources which lie near each other on the plane of the sky can determine their relative positions with sub-milliarcsecond uncertainties. A series of such observations well spread throughout the seasons of a pulsar and one or more extragalactic reference sources can yield the position, proper motion, and parallax of the pulsar, the latter providing a model-independent distance. These results could be used to check the calibration of the dispersion-based galactic distance scale, to investigate the properties of the free-electron density distribution in the solar neighborhood, and to study the spatial distribution and kinematics of the pulsars. We present an overview of our ongoing VLBI pulsar parallax program and discuss our results for the two pulsars (PSR 2021+51 and PSR 1929+10) which we have observed in four epochs since 1991 July.

We acknowledge support from NASA Grant NGR-50663 (RMC) and NSF Grants AST90-02087 (NB, IIS) and AST93-03527 (RMC, IIS); research at York University is partially supported by NSERC.

17.06

U.S. Naval Observatory's Programs to Determine Accurate Proper Motions of Faint Stars

S. E. Urban (USNO)

Currently, global, proper motion catalogs are limited to stars brighter than visual magnitude 10.5. In order to increase our knowledge of galactic kinematics as well as extend the optical reference frame, proper motions of fainter stars are required. A number of projects are underway at the USNO that will result in accurate positions and proper motions for stars of much fainter magnitudes. These projects include: new reductions of Astrophographic Catalogue (AC) data (average epoch about 1905); measurement and reductions of the USNO's twin astrogaph plates taken in the early 1980's; re-measurement and reduction of the Palomar Sky Survey plates; and a new program to accurately determine positions of all stars 14th magnitude and brighter using the USNO's 8" astrograph with improved optics. When combined, the results of these programs will give astrometric data for millions of stars whose current positions and proper motions are undetermined.

A cornerstone for proper motion determinations is the data contained in the Astrophropic Catalogue. The data's early epoch (about 1905), global coverage and positional accuracy make them the best source of first epoch positions for stars down to 13th magnitude. Each of the 22 AC zones is being reduced independently, with corrections being applied when needed for plate tilt, radial distortion, coma, magnitude equations and other field distortions. It is expected that the reductions of the entire AC, containing about five million stars, will be completed by the end of 1996.

17.07

The Hat Creek 3m Point Source Survey

Geoffrey Bower (UC Berkeley), Carl Heiles (UC Berkeley)

The ongoing Hat Creek 3 m Point Source Survey is the most sensitive and largest scale survey produced at 3 mm. The survey fills a wavelength gap in point source surveys that stretches from 6 cm to 100 microns. At present we have covered over one square degree of the northern sky with a point source sensitivity of 300 mJy. The selected region coincides with the location of a point source identified by the MSAM experiment. We have not detected any sources. Sources that may appear in continuum emission in our bandpass are extremely dusty objects whose emission peaks at wavelengths longer than 100 microns and synchrotron sources with turnover frequencies near or shortward of 3 mm.
18.01

The Bursting, Pulsing and Transient High Energy Sky as Seen by the BATSE Experiment on the Compton Observatory

Gerald J. Fishman (NASA/MSFC)

BATSE, the Burst and Transient Source Experiment on the Compton Gamma-Ray Observatory, has been providing a nearly continuous, all-sky monitoring capability above 20 keV since its launch in April 1991. A wide variety of astrophysical, solar, and geophysical phenomena have been observed and studied in detail by this experiment. Perhaps the most surprising observation has been the detection of an isotropic, yet inhomogeneous distribution of over one thousand gamma ray bursts. This has led many to infer a cosmological distance to the sources of these enigmatic objects. About twenty hard x-ray and gamma-ray pulsars have been observed; the nearly-continuous monitoring of them has allowed unprecedented timing observations. Earth occultation monitoring and imaging techniques have also been developed and continuously improved to detect and study a wide range of high-energy sources over the entire sky. For example, two Galactic relativistic jet transient sources have been studied in detail, and at least thirty galactic and three extragalactic hard x-ray sources are nearly continuously monitored. The experiment and a sample of the wide range of phenomena observed by BATSE will be described.

19.01

The Limits of the Universe

C. Hazard (University of Pittsburgh)

For the past thirty or so years QSOs have played a dominant role in extragalactic research and have provided prime targets for the large optical telescopes which have come into operation during this period. Because of their high intrinsic luminosity they provide the best tools that we have available for probing the structure, early history, and evolution of the universe. Bright examples are particularly valuable as probes of the intervening gas clouds and galaxies and for such fundamental investigations as the temperature of the microwave background and deuterium abundance at early epochs. The success of these investigations has depended on the discovery of these rare objects at higher and higher redshifts. This talk reviews the history of these surveys from the recognition of the nature of 3c273 to the latest large scale surveys which have extended our horizons out to redshifts greater than 5.
The spectral-energy distribution in the Far-UV is used to calculate the star-formation rate and the age of the starburst, with results consistent with those derived from IUE and imaging studies at longer wavelengths. For the HUT spectrum the best fit star-formation rate is $0.7 M_{\odot} yr^{-1}$, with an initial-mass function slope $\alpha = -1.5$, an upper mass limit of $100 M_{\odot}$, and an age of $9 \times 10^7$ yrs.

While the results are sensitive to the detailed shape of the extinction curve, an extrapolation "obscuration" curve of the Kinney et al. (1994) to the Lyman limit works reasonably well, with an inferred value of $E(B-V) = 0.34$ consistent with that derived from IUE spectra. Access to the region below 1200 Å provides interesting information on the relative distributions of dust, stars, and gas in M83. In the Milky Way, individual hot stars with $E(B-V)>0.2$ invariably show $H_2$ absorption features. The center of M83 has strong molecular CO emission, and therefore presumably molecular hydrogen. However, absorption due to $H_2$ is not obvious in the HUT spectrum, suggesting that most of the emission seen by HUT comes from stars that are not within the molecular gas, but are nevertheless behind significant amounts of dust and atomic gas.

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20.04

Hopskins Ultraviolet Telescope Observations of Six E and S0 Galaxies
T.M. Brown (JHU), H.C. Ferguson (STScI), A.F. Davidsoen (JHU)

In order to better understand the hot stellar populations of E and S0 galaxies, we observed six objects using the Hopkins Ultraviolet Telescope. Through our 11' x 60" aperture, we obtained one observation each of M 49 (1346 s), M 87 (950 s), M 89 (1682 s), and NGC 3115 (1634 s), two observations of NGC 3379 (3074 s), and four observations of M 60 (5824 s). The far-ultraviolet (FUV) spectra were obtained during orbital night as part of the Astro-2 mission on the space shuttle Endeavor in March 1995, and cover the spectral range of 912 Å to 1850 Å with a resolution of 2.4 Å. This sample quadruples the number of early-type galaxies studied to the Lyman limit.

After correcting for geocoronal emission and interstellar extinction in our own Galaxy, all the spectra are similar, even though the "UV upturn" strength, as characterized by the parameter $m_{550} - V$, varies over the range of 2.04 mag to 3.86 mag for these galaxies. Comparison with models of evolved stellar populations confirms the conclusion from Astro-1 data that the FUV flux can be explained by stars with a narrow range of temperature and envelope mass on the extreme horizontal branch (EHB).

This work was supported by NASA contract NAS 5-27000 to the Johns Hopkins University.

20.05

A Search for Far-UV Emission from Hot Gas in the Halo of NGC 4631
H. Ferguson (STScI), A.F. Davidsean, W.V. Dixon (JHU)

During the Astro-2 mission in March of 1995, the Hopkins Ultraviolet Telescope (HUT) was used to conduct a sensitive search for far-UV emission lines from hot gas in the halo of NGC 4631. This galaxy has a strong radio continuum emission, extended Hα emission, and soft X-ray emission from an extended halo. Recent ROSAT observations indicate that much of the X-ray emission comes from a very soft component, with temperature less than 6 x 10^6 K. Gas cooling through this temperature range should show emission in the prominent O VI λ1032, 1038 and C IV λ1548, 1550 lines.

The HUT observations probe a portion of the halo 39 arcseconds (corresponding to 1.4 kpc at an distance of 7.5 Mpc) south of the disk, through a 11' x 56" aperture. Neither emission line was detected. Implications for galactic fountain models will be discussed.

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