

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND TECHNOLOGY RESUME

TITLE

Studies of Asteroids, Comets, and Jupiter's Outer Satellites, NSG-7500

PERFORMING ORGANIZATION

Lowell Observatory

INVESTIGATOR'S NAME

Edward Bowell

DESCRIPTION (a. Brief statement on strategy of investigation; b. Progress and accomplishments of prior year; c. What will be accomplished this year, as well as how and why; and d. Summary bibliography)

(a) Our work comprises observational, theoretical, and computational research on asteroids, together with a smaller effort concerning the astrometry of comets and Jupiter's satellites JVI through JXIII. Two principal areas of research, centering on astrometry and photometry, are interrelated in their aim to study the overall structure of the asteroid belt and the physical and orbital properties of individual asteroids.

(b) We have measured and published about 2000 accurate photographic positions of asteroids and comets, including a number from the Lowell, Palomar, and Goethe-Link archival plate collections, the last of which was donated to us last winter by Indiana University. CCD astrometry of 36 faint targets was undertaken, including 4 comets; JVI, JVII, JVIII, JIX, JXI, and JXII; and 26 asteroids, most of which are Earth-approachers. We started a deep, bias-correctable asteroid survey (LUKAS), the aim of which is to determine the true spatial distribution of asteroids down to subkilometer diameters, and obtained a series of eight plates at the UK Schmidt telescope that contain images of asteroids as faint as $V \sim 22$ mag. Analysis of microdensitometric scans of two plates has shown that we can identify about 98% of the asteroid images completely automatically. A review called "Discovery and Follow-up of Asteroids" has been submitted to *Asteroids II*. Orbit files have been updated monthly, and orbits and ephemerides have been distributed to observers on request. We have completed work on a photometric study of Chiron (a paper is in press in *Icarus*), and we have started two CCD photometry tasks to determine rotational characteristics and surface light-scattering properties of asteroids: one on kilometer-size UCAS asteroids, and one on 11 selected main-belt asteroids in support of scale calibration for HST. Work on the so-called H, G magnitude system for asteroids is virtually complete and a manuscript will shortly be submitted to *Icarus*. A paper entitled "Modelling Asteroid Brightness Variations. I. Numerical Methods" has been submitted to *Astronomy and Astrophysics*, and a review on "Application of Photometric Models to Asteroids" is in preparation for *Asteroids II*. Good progress has been made on exploring the idea that the opposition spike, seen in the phase curves of icy satellites and some high-albedo asteroids, results from an admixture of transparent crystalline material.

(c) Our main astrometric effort will concern LUKAS, which we hope to get up to a "production" rate of two or three fields per year. We anticipate generating one- and two-month orbital arcs for perhaps 2000 small asteroids. Related work needs to be done on the problem of linking images from one plate to another, and this should result in a paper called "A Generalization of Väisälä's Method of Apsidal Orbit Determination". To accommodate the deep survey, our other photographic astrometry programs will be reduced in scope; but CCD astrometry of faint asteroids, Jupiter satellites, and comets should continue unabated, as should CCD photometry of small UCAS asteroids and HST scale-calibration asteroids. The work on lightcurve interpretation should progress to the completion of a paper entitled "Modelling Asteroid Brightness Variations. II. On the Uninterpretability of Phase Curves and Lightcurves"; and a third paper will be started concerning the displacement of an asteroid's photocenter with rotation and phase angle and the modelling of lightcurves of asteroids occulted by the Moon. We will also explore incorporating the opposition spike in a three-parameter version of the H, G magnitude system.

ORIGINAL PAGE IS
OF POOR QUALITY

(d) Summary Bibliography

- Bowell, E. (1987). [asteroid and comet observations]. *IAU Circular* Nos. 4416, 4469.
- Bowell, E. (1987). [asteroid and comet observations]. *Minor Planet Circular* Nos. 11925, 12040, 12181, 12284, 12287, 12362, 12410, 12425, 12513, 12532.
- Bowell, E. (1987). [asteroid identifications]. *Minor Planet Circular* Nos. 12130, 12136-12138, 12201, 12202, 12310-12313, 12320, 12412, 12438, 12440, 12442-12445, 12576.
- Bowell, E. (1988). [asteroid and comet observations]. *IAU Circular* No. 4572.
- Bowell, E. (1988). [asteroid and comet observations]. *Minor Planet Circular* Nos. 12650, 12661, 12664, 12765, 12769, 12773, 12775, 12911, 13007, 13017, 13130, 13133, 13134.
- Bowell, E. (1988). [asteroid identifications]. *Minor Planet Circular* Nos. 12696, 12705-12707, 12711, 12712, 12781, 12783, 12788, 12790, 12791, 12955, 13036, 13164, 13166.
- Bowell, E. (1988). [asteroid orbits]. *Minor Planet Circular* No. 12934.
- Bowell, E., Bus, S. J., and Cunningham, C. J. (1988). 1988 EG [photometry]. *IAU Circular* No. 4573.
- Bowell, E., Bus, S. J., Skiff, B. A., and Cunningham, C. J. (1988). (2060) Chiron [photometry]. *IAU Circular* No. 4579.
- Bowell, E., Chernykh, N. S., and Marsden, B. G. (1988). Discovery and follow-up of asteroids. Submitted to *Asteroids II*, (R. P. Binzel, T. Gehrels, and M. S. Matthews, eds.).
- Bowell, E., Harris, A. W., and Lumme, K. (1988). A two-parameter magnitude system for asteroids. To be submitted to *Icarus*.
- Bus, S. J. (1987). [asteroid and comet observations]. *Minor Planet Circular* Nos. 11925, 12410, 12513.
- Bus, S. J. (1987). [asteroid identifications]. *Minor Planet Circular* Nos. 12010, 12451, 12567.
- Bus S. J. (1988). [asteroid and comet observations]. *IAU Circular* No. 4572.
- Bus, S. J. (1988). [asteroid identifications]. *Minor Planet Circular* Nos. 12706, 12708, 12709, 12714, 12715, 12769, 12782, 12785, 12786, 12963, 13043, 13044.
- Bus, S. J. (1988). [asteroid and comet observations]. *Minor Planet Circular* Nos. 12650, 12661, 12747, 12749, 12765, 12791, 13007, 13017, 13130, 13133.
- Bus, S. J., Bowell, E., Harris, A. W., and Hewitt, A. V. (1988). 2060 Chiron: CCD and electronographic photometry. *Icarus*, in press.
- Hapke, B., Lumme, K., Bowell, E., Harris, A. W., Domingue, D., and Peltoniemi, J. (1988). Application of photometric models to asteroids. To be submitted to *Asteroids II*, (R. P. Binzel, T. Gehrels, and M. S. Matthews, eds.).
- Karttunen, H. (1988). Modelling asteroid brightness variations. I. Numerical methods. *Astron. Astrophys.*, in press.
- Millis, R. L., Piironen, J., and 40 other authors. The size, shape, density, and albedo of Ceres from its occultation of BD+8°471. *Icarus* **72**, 507-518.
- Skiff, B. A. (1987). [asteroid and comet observations]. *IAU Circular* Nos. 4416, 4469.
- Skiff, B. A. (1987). [asteroid and comet observations]. *Minor Planet Circular* Nos. 12040, 12181, 12287, 12362, 12413, 12425, 12532.
- Skiff, B. A. (1988). [asteroid and comet observations]. *IAU Circular* No. 4570.
- Skiff, B. A. (1988). [asteroid and comet observations]. *Minor Planet Circular* Nos. 12661, 12769, 12773, 12911, 13007, 13133, 13134.