

Vita

Michael C. Nolan

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Education

Doctor of Philosophy in Planetary Science, May 1994
The University of Arizona, Tucson. Advisor: Richard Greenberg

Bachelor of Science in Chemistry with Honor
California Institute of Technology, June 1985

Experience

- Senior Research Scientist, July 2015 to present. Lunar and Planetary Laboratory / University of Arizona.
- Senior Research Scientist, October 2011 to July 2015. Arecibo Observatory / Universities Space Research Association.
- Research Associate, Senior Research Associate, February 1995 to September 2011
Cornell University / National Astronomy and Ionosphere Center
- Research Associate, May 1994 to February 1995. Lunar and Planetary Laboratory, University of Arizona, Tucson
- National Science Foundation Graduate Fellow, Graduate Research Associate, August 1986 to May 1994. Lunar and Planetary Laboratory, University of Arizona, Tucson

Science / Technical Duties

Mission Geophysical Scientist, OSIRIS-REx spacecraft mission, University of Arizona, July 2015 to present.

OSIRIS-REx mission Science Team Chief

- Responsible to coordinate the activities of multiple science working groups with mission project engineering.
- Chair of OSIRIS-REx Site Selection Board

Deputy Director for Planetary Sciences, Arecibo Observatory, October 2011 to July 2015.

- Responsible for the funding and operation of the Arecibo Planetary Radar system at the Arecibo Observatory, with over \$3.5M annual funding.

- Oversee the Arecibo Observatory Space Academy program for high-school students and K-12 teachers.

Acting Director for Arecibo Operations, August 2014 to July 2015. Universities Space Research Association.

- Responsible for the USRA portion of the operation of the Arecibo Observatory, comprising the Astronomy, Planetary, Electronics, and Computing staff.

Observatory Director, Arecibo Observatory, August 2008 to September 2011

National Astronomy and Ionosphere Center / Cornell University, Arecibo, Puerto Rico

Managed the operation of the Arecibo Observatory, a NSF-funded research facility with approximately 100 full-time equivalent staff including research scientists, engineering staff, and physical plant. Duties included:

- Planning, coordination, execution, and management of broad scientific programs which concentrated on the nature and history of the asteroids, comets, planets and satellites in the Solar System.
- Planning, coordinating, and implementing partnerships and/or cooperative agreements with Federal, Commonwealth of Puerto Rico and local agencies, academic institutions, and private organizations.
- Defining the overall problems to be addressed by the staff, describing the scope and objectives of intermediate and long-range programs, developing proposals for accomplishing these programs, including fiscal estimates, number of employees, and other requirements.
- Providing advice and guidance to top university management on national and regional scientific issues.
- Acting as the spokesperson for the observatory in matters relating to research, monitoring, assessments, and national and international issues.
- Management of the observatory through subordinate supervisors.
- Responsibility for developing new technology critical to the observatory's observational program and for maintaining the observatory at the state of the art.
- Providing advice and direction for senior technical experts on how to develop equipment for the observatory and to internal and external scientists on use and development of new systems.
- Liaison between technical departments and scientific users on equipment development and scientific needs.
- Responsibility for maintaining an effective observatory operation during the 2011 management transition of the observatory.

Assistant Director for Technical Services, Arecibo Observatory, May 2006 to August 2008

Head, Planetary Radar group, Arecibo Observatory. May 2004 to September 2011.

Research Experience

In all of those positions, I maintained a similar set of technical and scientific projects using radar observations of asteroids, comets, and meteors to constrain the delivery of meteorites to the Earth.

- Radar observation of asteroids and comparison with numerical impact modelling.
- Training users in the use of the Arecibo Observatory Planetary Radar System.
- Radar astrometry in support of NASA spacecraft mission navigation.
- Numerical simulation of asteroid and meteorite delivery to the Earth.
- Commissioning the Arecibo 305 m radio telescope and planetary radar system, with emphasis on improvement of system performance.
- Numerical modelling of impacts on the Galilean satellites.
- Supervision of undergraduate students for summer research projects. I was the primary supervisor for nine undergraduate interns from 1998 to 2014. Each of these projects resulted in at least one conference presentation. One paper (Becker et al., 2015) was published in *Icarus*.

Awards

NASA Outstanding Public Leadership Medal

Memberships

Division of Planetary Sciences of the American Astronomical Association

International Astronomical Union

American Geophysical Union

Meteoritical Society

European Geophysical Union

American Association for the Advancement of Science

Institute of Electrical and Electronics Engineers

Publications

Peer Reviewed Journal Publications

Shepard, M. K., B. Timerson, D. J. Scheeres, L. A. M. Benner, J. D. Giorgini, E. S. Howell, C. Magri, M. C. Nolan, A. Springmann, P. A. Taylor, and A. Virkki 2018. A revised shape model of asteroid (216) Kleopatra. *Icarus* **311**, 197–209.

Hickson, D., A. Boivin, M. G. Daly, R. Ghent, M. C. Nolan, K. Tait, A. Cunje, and C. A. Tsai 2018. Near surface bulk density estimates of NEAs from radar observations and permittivity measurements of powdered geologic material. *Icarus* **306**, 16–24.

- Howell, E. S., C. Magri, R. J. Vervack, M. C. Nolan, P. A. Taylor, Y. R. Fernández, M. D. Hicks, J. M. Somers, K. J. Lawrence, A. S. Rivkin, S. E. Marshall, and J. L. Crowell 2018. SHERMAN - A shape-based thermophysical model II. Application to 8567 (1996 HW1). *Icarus* **303**, 220–233.
- Magri, C., E. S. Howell, R. J. Vervack, M. C. Nolan, Y. R. Fernández, S. E. Marshall, and J. L. Crowell 2018. SHERMAN, a shape-based thermophysical model. I. Model description and validation. *Icarus* **303**, 203–219.
- Brozović, M., L. A. M. Benner, J. G. McMichael, J. D. Giorgini, P. Pravec, P. Scheirich, C. Magri, M. W. Busch, J. S. Jao, C. G. Lee, L. G. Snedeker, M. A. Silva, M. A. Slade, B. Semenov, M. C. Nolan, P. A. Taylor, E. S. Howell, and K. J. Lawrence 2018. Goldstone and Arecibo radar observations of (99942) Apophis in 2012-2013. *Icarus* **300**, 115–128.
- Lawrance, K., L. A. M. Benner, M. Brozovic, S. J. Ostro, J. Jao, J. D. Giorgini, M. Slade, R. F. Jurgens, M. C. Nolan, E. S. Howell, and P. A. Taylor 2018. Arecibo and Goldstone Radar Images of Near-Earth Asteroid (469896) 2005 WC1. *Icarus* **300**, 12–20.
- Lauretta, D. S., S. S. Balram-Knutson, E. Beshore, W. V. Boynton, C. Drouet d’Aubigny, D. N. DellaGiustina, H. L. Enos, D. R. Golish, C. W. Hergenrother, E. S. Howell, C. A. Bennett, E. T. Morton, M. C. Nolan, B. Rizk, H. L. Roper, A. E. Bartels, B. J. Bos, J. P. Dworkin, D. E. Highsmith, D. A. Lorenz, L. F. Lim, R. Mink, M. C. Moreau, J. A. Nuth, D. C. Reuter, A. A. Simon, E. B. Bierhaus, B. H. Bryan, R. Ballouz, O. S. Barnouin, R. P. Binzel, W. F. Bottke, V. E. Hamilton, K. J. Walsh, S. R. Chesley, P. R. Christensen, B. E. Clark, H. C. Connolly, M. K. Crombie, M. G. Daly, J. P. Emery, T. J. McCoy, J. W. McMahon, D. J. Scheeres, S. Messenger, K. Nakamura-Messenger, K. Righter, and S. A. Sandford 2017. OSIRIS-REx: Sample Return from Asteroid (101955) Bennu. *Space Sci. Rev.* **212**, 925–984.
- Daly, M. G., O. S. Barnouin, C. Dickinson, J. Seabrook, C. L. Johnson, G. Cunningham, T. Haltigin, D. Gaudreau, C. Brunet, I. Aslam, A. Taylor, E. B. Bierhaus, W. Boynton, M. Nolan, and D. S. Lauretta 2017. The OSIRIS-REx Laser Altimeter (OLA) Investigation and Instrument. *Space Sci. Rev.* **212**, 899–924.
- Marshall, S. E., E. S. Howell, C. Magri, R. J. Vervack, D. B. Campbell, Y. R. Fernández, M. C. Nolan, J. L. Crowell, M. D. Hicks, K. J. Lawrence, and P. A. Taylor 2017. Thermal Properties and an Improved Shape Model for Near-Earth Asteroid (162421) 2000 ET70. *Icarus* **292**, 22–35.
- Crowell, J. L., E. S. Howell, C. Magri, M. C. Nolan, Y. R. Fernández, J. E. Richardson, B. D. Warner, S. E. Marshall, A. Springmann, and R. J. Vervack 2017. Radar and Lightcurve Shape Model of Near-Earth Asteroid (1627) Ivar. *Icarus* **291**, 254–267.
- Brozović, M., L. A. M. Benner, C. Magri, D. J. Scheeres, M. W. Busch, J. D. Giorgini, M. C. Nolan, J. S. Jao, C. G. Lee, L. G. Snedeker, M. A. Silva, K. J. Lawrence, M. A. Slade, M. D. Hicks, E. S. Howell, P. A. Taylor, J. A. Sanchez, V. Reddy, M. Dykhuis, and L. L. Corre 2017. Goldstone Radar Evidence for Short-Axis Mode Non-Principal-Axis Rotation of Near-Earth Asteroid (214869) 2007 PA8. *Icarus* **286**, 314–329.

- Patterson, G. W., A. M. Stickle, F. S. Turner, J. R. Jensen, D. B. J. Bussey, P. Spudis, R. C. Espiritu, R. C. Schulze, D. A. Yocky, D. E. Wahl, M. Zimmerman, J. T. S. Cahill, M. Nolan, L. Carter, C. D. Neish, R. K. Raney, B. J. Thomson, R. Kirk, T. W. Thompson, B. L. Tise, I. A. Erteza, and C. V. Jakowatz 2017. Bistatic Radar Observations of the Moon Using Mini-RF on LRO and the Arecibo Observatory. *Icarus* **283**, 2–19.
- Shepard, M. K., J. Richardson, P. A. Taylor, L. A. Rodriguez-Ford, A. Conrad, I. de Pater, M. Adamkovics, K. de Kleer, J. R. Males, K. M. Morzinski, L. M. Close, M. Kaasalainen, M. Viikinkoski, B. Timerson, V. Reddy, C. Magri, M. C. Nolan, E. S. Howell, L. A. M. Benner, J. D. Giorgini, B. D. Warner, and A. W. Harris 2017. Radar Observations and Shape Model of Asteroid 16 Psyche. *Icarus* **281**, 388–403.
- Harmon, J. K. and M. C. Nolan 2017. Arecibo Radar Imagery of Mars: II. Chryse-Xanthe, Polar Caps, and Other Regions. *Icarus* **281**, 162–199.
- Hickson, D., S. Sotodeh, M. G. Daly, R. Ghent, and M. C. Nolan 2017. Improvements on Effective Permittivity Measurements of Powdered Alumina: Implications for Bulk Permittivity Properties of Asteroid Regoliths. *Advances in Space Research* **59**, 472–482.
- Scheeres, D. J., S. G. Hesar, S. Tardivel, M. Hirabayashi, D. Farnocchia, J. W. McMahon, S. R. Chesley, O. Barnouin, R. P. Binzel, W. F. Bottke, M. G. Daly, J. P. Emery, C. W. Hergenrother, D. S. Lauretta, J. R. Marshall, P. Michel, M. C. Nolan, and K. J. Walsh 2016. The Geophysical Environment of Bennu. *Icarus* **276**, 116–140.
- Binzel, R. P., F. E. DeMeo, B. J. Burt, E. A. Cloutis, B. Rozitis, T. H. Burbine, H. Campins, B. E. Clark, J. P. Emery, C. W. Hergenrother, E. S. Howell, D. S. Lauretta, M. C. Nolan, M. Mansfield, V. Pietrasz, D. Polishook, and D. J. Scheeres 2015. Spectral slope variations for OSIRIS-REx target Asteroid (101955) Bennu: Possible evidence for a fine-grained regolith equatorial ridge. *Icarus* **256**, 22–29.
- Naidu, S. P., J. L. Margot, P. A. Taylor, M. C. Nolan, M. W. Busch, L. A. M. Benner, M. Brozovic, J. D. Giorgini, J. S. Jao, and C. Magri 2015. Radar Imaging and Characterization of the Binary Near-Earth Asteroid (185851) 2000 DP107. *AJ* **150**, 54.
- Lauretta, D. S., A. E. Bartels, M. A. Barucci, E. B. Bierhaus, R. P. Binzel, W. F. Bottke, H. Campins, S. R. Chesley, B. C. Clark, B. E. Clark, E. A. Cloutis, H. C. Connolly, M. K. Crombie, M. Delbó, J. P. Dworkin, J. P. Emery, D. P. Glavin, V. E. Hamilton, C. W. Hergenrother, C. L. Johnson, L. P. Keller, P. Michel, M. C. Nolan, S. A. Sandford, D. J. Scheeres, A. A. Simon, B. M. Sutter, D. Vokrouhlický, and K. J. Walsh 2015. The OSIRIS-REx target asteroid (101955) Bennu: Constraints on its physical, geological, and dynamical nature from astronomical observations. *Meteoritics and Planetary Science* **50**, 834–849.
- Campbell, B. A., D. B. Campbell, G. A. Morgan, L. M. Carter, M. C. Nolan, and J. F. Chandler 2015. Evidence for crater ejecta on Venus tessera terrain from Earth-based radar images. *Icarus* **250**, 123–130.

- Becker, T. M., E. S. Howell, M. C. Nolan, C. Magri, P. Pravec, P. A. Taylor, J. Oey, D. Higgins, J. Világi, L. Kornoš, A. Galád, Š. Gajdoš, N. M. Gaftonyuk, Y. N. Krugly, I. E. Molotov, M. D. Hicks, A. Carbognani, B. D. Warner, F. Vachier, F. Marchis, and J. T. Pollock 2015. Physical modeling of triple near-Earth Asteroid (153591) 2001 SN₂₆₃ from radar and optical light curve observations. *Icarus* **248**, 499–515.
- Shepard, M. K., P. A. Taylor, M. C. Nolan, E. S. Howell, A. Springmann, J. D. Giorgini, B. D. Warner, A. W. Harris, R. Stephens, W. J. Merline, A. Rivkin, L. A. M. Benner, D. Coley, B. E. Clark, M. Ockert-Bell, and C. Magri 2015. A radar survey of M- and X-class asteroids. III. Insights into their composition, hydration state, & structure. *Icarus* **245**, 38–55.
- Bolin, B., R. Jedicke, M. Granvik, P. Brown, E. Howell, M. C. Nolan, P. Jenniskens, M. Chyba, G. Patterson, and R. Wainscoat 2014. Detecting Earth’s temporarily-captured natural satellites-Minimoons. *Icarus* **241**, 280–297.
- Chesley, S. R., D. Farnocchia, M. C. Nolan, D. Vokrouhlický, P. W. Chodas, A. Milani, F. Spoto, B. Rozitis, L. A. M. Benner, W. F. Bottke, M. W. Busch, J. P. Emery, E. S. Howell, D. S. Lauretta, J.-L. Margot, and P. A. Taylor 2014. Orbit and bulk density of the OSIRIS-REx target Asteroid (101955) Bennu. *Icarus* **235**, 5–22.
- Campbell, B. A., B. Ray Hawke, G. A. Morgan, L. M. Carter, D. B. Campbell, and M. Nolan 2014. Improved discrimination of volcanic complexes, tectonic features, and regolith properties in Mare Serenitatis from Earth-based radar mapping. *Journal of Geophysical Research (Planets)* **119**, 313–330.
- Consolmagno, G. J., M. W. Schaefer, B. E. Schaefer, D. T. Britt, R. J. Macke, M. C. Nolan, and E. S. Howell 2013. The measurement of meteorite heat capacity at low temperatures using liquid nitrogen vaporization. *Planet. Space Sci.* **87**, 146–156.
- Nolan, M. C., C. Magri, E. S. Howell, L. A. M. Benner, J. D. Giorgini, C. J. Hergenrother, R. S. Hudson, D. S. Lauretta, J. L. Margot, S. J. Ostro, and D. J. Scheeres 2013. Asteroid (101955) Bennu Shape Model V1.0. *NASA Planetary Data System* **211**.
- Hergenrother, C. W., M. C. Nolan, R. P. Binzel, E. A. Cloutis, M. A. Barucci, P. Michel, D. J. Scheeres, C. D. d’Aubigny, D. Lazzaro, N. Pinilla-Alonso, H. Campins, J. Licandro, B. E. Clark, B. Rizk, E. C. Beshore, and D. S. Lauretta 2013. Lightcurve, Color and Phase Function Photometry of the OSIRIS-REx Target Asteroid (101955) Bennu. *Icarus* **226**, 663–670.
- Nolan, M. C., C. Magri, E. S. Howell, L. A. M. Benner, J. D. Giorgini, C. W. Hergenrother, R. S. Hudson, D. S. Lauretta, J.-L. Margot, S. J. Ostro, and D. J. Scheeres 2013. Shape Model and Surface Properties of the OSIRIS-REx Target Asteroid (101955) Bennu from Radar and Lightcurve Observations. *Icarus* **226**, 629–640.

- Naidu, S. P., J.-L. Margot, M. W. Busch, P. A. Taylor, M. C. Nolan, M. Brozovic, L. A. M. Benner, J. D. Giorgini, and C. Magri 2013. Radar imaging and physical characterization of near-Earth Asteroid (162421) 2000 ET70. *Icarus* **226**, 323–335.
- Jensen, E. A., M. Nolan, M. M. Bisi, I. Chashei, and F. Vilas 2013. MESSENGER Observations of Magnetohydrodynamic Waves in the Solar Corona from Faraday Rotation. *Sol. Phys.* **285**, 71–82.
- Rivkin, A. S., E. S. Howell, R. J. Vervack, C. Magri, M. C. Nolan, Y. R. Fernandez, A. F. Cheng, M. Antonietta Barucci, and P. Michel 2013. The NEO (175706) 1996 FG3 in the 2–4 μm Spectral region: Evidence for an Aqueously Altered Surface. *Icarus* **223**, 493–498.
- Harmon, J. K., M. C. Nolan, D. I. Husmann, and B. A. Campbell 2012. Arecibo Radar Imagery of Mars: The Major Volcanic Provinces. *Icarus* **220**, 990–1030.
- Brozović, M., L. A. M. Benner, P. A. Taylor, M. C. Nolan, E. S. Howell, C. Magri, D. J. Scheeres, J. D. Giorgini, J. T. Pollock, P. Pravec, A. Galád, J. Fang, J.-L. Margot, M. W. Busch, M. K. Shepard, D. E. Reichart, K. M. Ivarsen, J. B. Haislip, A. P. Lacluyze, J. Jao, M. A. Slade, K. J. Lawrence, and M. D. Hicks 2011. Radar and optical observations and physical modeling of triple near-Earth Asteroid (136617) 1994 CC. *Icarus* **216**, 241–256.
- Shepard, M. K., A. W. Harris, P. A. Taylor, B. E. Clark, M. Ockert-Bell, M. C. Nolan, E. S. Howell, C. Magri, J. D. Giorgini, and L. A. M. Benner 2011. Radar observations of Asteroids 64 Angelina and 69 Hesperia. *Icarus* **215**, 547–551.
- Magri, C., E. S. Howell, M. C. Nolan, P. A. Taylor, Y. R. Fernández, M. Mueller, R. J. Vervack, L. A. M. Benner, J. D. Giorgini, S. J. Ostro, D. J. Scheeres, M. D. Hicks, H. Rhoades, J. M. Somers, N. M. Gaftonyuk, V. V. Kouprianov, Y. N. Krugly, I. E. Molotov, M. W. Busch, J.-L. Margot, V. Benishek, V. Protitch-Benishek, A. Galád, D. Higgins, P. Kušnirák, and D. P. Pray 2011. Radar and photometric observations and shape modeling of contact binary near-Earth Asteroid (8567) 1996 HW1. *Icarus* **214**, 210–227.
- Harmon, J. K., M. C. Nolan, E. S. Howell, J. D. Giorgini, and P. A. Taylor 2011. Radar Observations of Comet 103P/Hartley 2. *ApJ* **734**, L2.
- Meech, K. J., M. F. A’Hearn, J. A. Adams, P. Bacci, J. Bai, L. Barrera, M. Battelino, J. M. Bauer, E. Becklin, B. Bhatt, N. Biver, D. Bockelée-Morvan, D. Bodewits, H. Bönhardt, J. Boissier, B. P. Bonev, W. Borghini, J. R. Brucato, E. Bryssinck, M. W. Buie, H. Canovas, D. Castellano, S. B. Charnley, W. P. Chen, P. Chiang, Y.-J. Choi, D. J. Christian, Y.-L. Chuang, A. L. Cochran, P. Colom, M. R. Combi, I. M. Coulson, J. Crovisier, N. Dello Russo, K. Dennerl, K. DeWahl, M. A. DiSanti, M. Facchini, T. L. Farnham, Y. Fernández, H. G. Florén, U. Frisk, T. Fujiyoshi, R. Furusho, T. Fuse, G. Galli, D. A. García-Hernández, A. Gersch, Z. Getu, E. L. Gibb, M. Gillon, E. Guido, R. A. Guillermo, E. Hadamcik, O. Hainaut, H. B. Hammel, D. E. Harker, J. K. Harmon, W. M. Harris, P. Hartogh, M. Hashimoto, B. Häusler, T. Herter, A. Hjalmarson, S. T. Holland,

- M. Honda, S. Hosseini, E. S. Howell, N. Howes, H. H. Hsieh, H.-Y. Hsiao, D. Hutsemékers, S. M. Immler, W. M. Jackson, S. V. Jeffers, E. Jehin, T. J. Jones, M. d. J. Ovelar, H. M. Kaluna, T. Karlsson, H. Kawakita, J. V. Keane, L. D. Keller, M. S. Kelley, D. Kinoshita, N. N. Kiselev, J. Kleyna, M. M. Knight, H. Kobayashi, H. A. Kobulnicky, L. Kolokolova, M. Kreiny, Y.-J. Kuan, M. Küppers, J. M. Lacruz, W. B. Landsman, L. M. Lara, A. Lecacheux, A. C. Levasseur-Regourd, B. Li, J. Licandro, R. Ligustri, Z.-Y. Lin, M. Lippi, D. C. Lis, C. M. Lisse, A. J. Lovell, S. C. Lowry, H. Lu, S. Lundin, K. Magee-Sauer, P. Magain, J. Manfroid, E. Mazzotta Epifani, A. McKay, M. D. Melita, H. Mikuz, S. N. Milam, G. Milani, M. Min, R. Moreno, B. E. A. Mueller, M. J. Mumma, M. Nicolini, M. C. Nolan, H. L. Nordh, P. B. Nowajewski, Odin Team, T. Ootsubo, L. Paganini, C. Perrella, J. Pittichová, E. Prosperi, Y. L. Radeva, W. T. Reach, A. J. Remijan, M. Rengel, T. E. Riesen, M. Rodenhuis, D. P. Rodríguez, R. W. Russell, D. K. Sahu, N. H. Samarasinha, A. Sánchez Caso, A. Sandqvist, G. Sarid, M. Sato, D. G. Schleicher, E. W. Schwieterman, A. K. Sen, D. Shenoy, J.-C. Shi, Y. Shinnaka, J. Skvarc, C. Snodgrass, M. L. Sitko, S. Sonnett, S. Sosseini, G. Sostero, S. Sugita, B. M. Swinyard, S. Szutowicz, N. Takato, P. Tanga, P. A. Taylor, G.-P. Tozzi, R. Trabatti, J. M. Trigo-Rodríguez, C. Tubiana, M. de Val-Borro, W. Vacca, B. Vandenbussche, J. Vaubaillon, F. P. Velichko, S. F. Velichko, R. J. Vervack, Jr., M. J. Vidal-Nunez, G. L. Villanueva, C. Vinante, J.-B. Vincent, M. Wang, L. H. Wasserman, J. Watanabe, H. A. Weaver, P. R. Weissman, S. Wolk, D. H. Wooden, C. E. Woodward, M. Yamaguchi, T. Yamashita, P. A. Yanamandra-Fischer, B. Yang, J.-S. Yao, D. K. Yeomans, T. Zenn, H. Zhao, and J. E. Ziffer 2011. EPOXI: Comet 103P/Hartley 2 Observations from a Worldwide Campaign. *ApJ* **734**, L1.
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- Busch, M. W., S. R. Kulkarni, W. Briskin, S. J. Ostro, L. A. M. Benner, J. D. Giorgini, and M. C. Nolan 2010. Determining asteroid spin states using radar speckles. *Icarus* **209**, 535–541.
- Harmon, J. K., M. C. Nolan, E. S. Howell, J. D. Giorgini, N. H. Samarasinha, B. E. A. Mueller, M. F. A’Hearn, T. L. Farnham, M. Drahus, D. Jewitt, A. Guilbert, D. Lis, and W. Waniak 2010a. Comet 103P/Hartley. *Central Bureau Electronic Telegrams* **2515**, 1.
- Campbell, B. A., L. M. Carter, D. B. Campbell, M. Nolan, J. Chandler, R. R. Ghent, B. Ray Hawke, R. F. Anderson, and K. Wells 2010. Earth-based 12.6-cm wavelength radar mapping of the Moon: New views of impact melt distribution and mare physical properties. *Icarus* **208**, 565–573.

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