

Professor Shane Byrne Pronouns: He/Him/His	Department of Planetary Sciences University of Arizona
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Professional Positions

University of Arizona – Lunar and Planetary Laboratory

Professor & Director: Space Imagery Center (2007 – Present)

Assistant Department Head (2017 – Present)

Research Associate – with HiRISE team. (9/2005 – 8/2007)

Massachusetts Institute of Technology, 12/2003 – 9/2005.

Postdoctoral Scholar – with Professor Maria Zuber.

California Institute of Technology, 6/2003 – 12/2003.

Assistant Scientist – with Professor Bruce Murray.

California Institute of Technology, 8/1998 – 6/2003.

Graduate Research Assistant – with Professors Murray and Ingersoll.

Education

California Institute of Technology, Pasadena, CA. 1998-2003

Ph.D. Planetary Science, with minor in Astronomy (2003)

Advisors: Professors Bruce C. Murray and Andrew P. Ingersoll

M.S. Planetary Science, with minor in Astronomy (2001)

University of Cardiff, Cardiff, United Kingdom 1994-1998

Master of Physics. Astrophysics (1998)

Planetary Mission and Technology Development

- COMPASS Discovery proposal (2019) – PI
- Cold-Light Imager for Europa (C-LIFE) – PI [COLDTech and ICEE-2]
- Colour and Stereo Surface Imaging System (CaSSIS) – Co-Investigator
- High Resolution Science Experiment (HiRISE) – Co-Investigator & Deputy-PI.
- Dawn Mission at Ceres (2014-2018) – Guest Investigator
- High-Resolution Stereo Color Imager (HiSCI) (2010-2012) – Deputy-PI.
- Europa Camera Suite (ECAMS) proposal (2014) – Co-investigator
- Chronos Mars-scout proposal (2006) – Co-Investigator.
- MOSAIC Mars-scout proposal (2006) – Co-Investigator.
- Boreale Explorer Mars-scout proposal (2006) – Co-Investigator.
- Mars Orbiter Laser Altimeter (MOLA) (2002-2006).

Other Professional Activity

- NASA: Director of Space Imagery Center
A NASA Regional Planetary Image Facility
Mars Architecture Strategy Working Group (MASWG)
Ice and Climate Evolution Science Analysis Group (ICESAG)
NeMO Science Definition Team

- MAPSIT (formerly the Planetary Cartography and Geologic Mapping Working Group) (2012-2016)
 Numerous NASA proposal review panels and external reviewer
- Conferences: Science organization committee: Mars Polar Science 2020
 Keck Institute for Space Studies workshop convener 2017
 Local organization committee: DPS 2014
 Science organization committee: Mars Polar Science 2011
 Science organization committee: DPS 2011
 Session convener – AGU 2008
 - Member: American Geophysical Union
 American Astronomical Society – Division of Planetary Science
 - Awards: UA: Outstanding Faculty for Graduate Students – 2nd place (2017)
 NASA: Group Achievement Award, MRO HiRISE Team (2011)
 Caltech: Excellence in teaching award (2001).

Classes Taught

- U. of Arizona, PTYS 554: Evolution of Planetary Surfaces
- U. of Arizona, PTYS 594: Planetary Geology Field Studies
- U. of Arizona, PTYS 411/511: Geology and Geophysics of the Solar System
- U. of Arizona, PTYS 395A: Mercury: Open Questions and New Data.
- U. of Arizona, PTYS 395B: The Moon.
- U. of Arizona, PTYS 206: Our golden age of planetary exploration
- *Contributed lectures:*
 - U. of Arizona: PTYS442/542: Mars
 - MIT, EAPS 12.601: Essentials of Planetary Science
 - Caltech, Ge151: Fundamentals of Planetary Surfaces
 - Caltech, Ge158: Applications of Remote Sensing in the Field

Peer-Reviewed Publications

- Duarte, K.D., B.E. Schmidt, H.T. Chilton, K.H.G. Hughson, H.G. Sizemore, K.L. Ferrier, J.J. Buffo, J.E.C. Scully, A. Nathues, T. Platz, M. Landis, **S. Byrne**, M. Bland, C. T. Russell, and C.A. Raymond (2019), Landslides on Ceres: Diversity and geologic context, *J. Geophys. Res.*, 124, 2019.
- Sori, M.M., J. Bapst, P. Becerra, and **S. Byrne** (2019), Islands of ice on Mars and Pluto. *Journal of Geophysical Research (Planets)* 124, 2522, 2019.
- Chilton, H.T., B.E. Schmidt, K. Duarte, K.L. Ferrier, K.H.G. Hughson, J.E.C. Scully, J.J. Wray, H.G. Sizemore, A. Nathues, T. Platz, N. Schorghofer, P.M. Schenk, M.E. Landis, M. Bland, **S. Byrne**, C.T.R. Russell, and C.A. Raymond (2019), Landslides on Ceres: Inferences into ice content and layering in the upper crust, *J. Geophys. Res.*, In Press, 2019.
- Bapst, J., **S. Byrne**, J.L. Bandfield, and P.O. Hayne (2019), Thermophysical Properties of the North Polar Residual Cap using MGS TES, *J. Geophys. Res.*, In Press, 2019.
- Bramson, A. M., **S. Byrne**, J. Bapst, I.B. Smith, and T. McClintock (2019). A migration model for the polar spiral troughs of Mars, *J. Geophys. Res.*, 124, 2019.

- Landis, M.E., **S. Byrne**, J.-Ph. Combe, S. Marchi, J. Castillo-Rogez, H.G. Sizemore, N. Schörghofer, T.H. Prettyman, P.O. Hayne, C.A. Raymond, C.T. Russell (2019), Water Vapor Contribution to Ceres' Exosphere from Observed Surface Ice and Postulated Ice-Exposing Impacts, *J. Geophys. Res.*, 124, 61-75, 2019.
- Combe, J.-P., A. Raponi, F. Tosi, M.C. De Sanctis, F.G. Carrozzo, F. Zambon, E. Ammannito, K.H.G. Hughson, A. Nathues, M. Hoffmann, T. Platz, G. Thangjam, N. Schorghofer, S. Schröder, **S. Byrne**, M.E. Landis, O. Ruesch, T.B. McCord, K.E. Johnson, S.M. Singh, C.A. Raymond and C.T. Russell (2019), Exposed H₂O-rich areas detected on Ceres with the dawn visible and infrared mapping spectrometer, *Icarus*, 318, 22-41, 2019.
- Ruesch, O., L.C. Quick, M.E. Landis, M.M. Sori, O. Čadek, P. Brož, K.A. Otto, M.T. Bland, **S. Byrne**, J.C. Castillo-Rogez, H. Hiesinger, R. Jaumann, K. Krohn, L.A. McFadden, A. Nathues, A. Neesemann, F. Preusker, T. Roatsch, P.M. Schenk, J.E.C. Scully, M.V. Sykes, D.A. Williams, C.A. Raymond and C.T. Russell (2019), Bright carbonate surfaces on Ceres as remnants of salt-rich water fountains, *Icarus*, 320, 39-48, 2019.
- Sori, M.M., H.G. Sizemore, **S. Byrne**, A.M. Bramson, M.T. Bland, N.T. Stein, and C.T. Russell (2018), Cryovolcanic rates on Ceres revealed by topography, *Nature Astronomy*, 2018.
- Savage, R., L.F. Palafox, C.T. Morrison, J.J. Rodriguez, K. Barnard, **S. Byrne**, and C.W. Hamilton (2018), A Bayesian Approach to Subkilometer Crater Shape Analysis Using Individual HiRISE Images, *IEEE Transactions On Geoscience And Remote Sensing*, 56, 5802-5812, 2018.
- Dundas, C.M., A.M. Bramson, L. Ojha, J.J. Wray, M.T. Mellon, **S. Byrne**, A.S. McEwen, N.E. Putzig, D. Viola, S. Sutton, E. Clark, J.W. Holt (2018), Exposed subsurface ice sheets in the Martian mid-latitudes, *Science*, 359, 199–201, 2018.
- Bapst, J., **S. Byrne**, A.J. Brown (2018), On the icy edge at Louth and Korolev craters, *Icarus*, 308, 15-26, 2018.
- Bramson, A.M., **S. Byrne**, J. Bapst (2017), Preservation of Mid-Latitude Ice Sheets on Mars, *J. Geophys. Res.*, 122, 11, 2250-2266, 2017.
- Landis, M.E., **S. Byrne**, N. Schörghofer, B.E. Schmidt, P.O. Hayne, J. Castillo-Rogez, M.V. Sykes, J.-P. Combe, A. I. Ermakov, T.H. Prettyman, C. Raymond, C.T. Russell. (2017), Conditions for Sublimating Water Ice to Supply Ceres' Exosphere, *J. Geophys. Res.*, 122, 10, 1984-1995.
- Schorghofer, N., **S. Byrne**, M.E. Landis, E. Mazarico, T.H. Prettyman, B.E. Schmidt, M.N. Villarreal, J. Castillo-Rogez, C.A. Raymond, and C.T. Russell (2017), The Putative Cerean Exosphere, *Astrophys. J.*, 850, 1, 85, 2017.
- Dundas, C.M., A.S. McEwen, M. Chojnacki, M.P. Milazzo, **S. Byrne**, J.N. McElwaine, A. Urso (2017), Granular flows at Recurring Slope Lineae on Mars indicate a limited role for liquid water, *Nature Geoscience*, 10, 903-907, 2017.
- Thomas, N., G. Cremonese, R. Ziethé, M. Gerber, M. Brändli, G. Bruno, M. Erismann, L. Gambicorti, T. Gerber, K. Ghose, M. Gruber, P. Gubler, H. Mischler, J. Jost, D. Piazza, A. Pommerol, M. Rieder, V. Roloff, A. Servonet, W. Trottmann, T. Uthacharoenpong, C. Zimmermann, D. Vernani, M. Johnson, E. Pelò, T. Weigel,

- J. Viertl, N. De Roux, P. Lochmatter, G. Sutter, A. Casciello, T. Hausner, I. Fikai, Veltroni, V. Da Deppo, P. Orleanski, W. Nowosielski, T. Zawistowski, S. Szalai, B. Sodor, S. Tulyakov, G. Troznai, M. Banaskiewicz, J.C. Bridges, **S. Byrne**, S. Debei, M.R. El-Maarry, E. Hauber, C.J. Hansen, A. Ivanov, L. Keszthelyi, R. Kirk, R. Kuzmin, N. Mangold, L. Marinangeli, W.J. Markiewicz, M. Massironi, A.S. McEwen, C. Okubo, L.L. Tornabene, P. Wajer and J.J. Wray (2017), The Colour and Stereo Surface Imaging System (CaSSIS) for the ExoMars Trace Gas Orbiter, *Space Sci. Review*, 212, 3-4, 1897-1944, 2017.
- Tornabene, L.L., F.P. Seelos, A. Pommerol, N. Thomas, C.M. Caudill, P. Becerra, J.C. Bridges, **S. Byrne**, M. Cardinale, M. Chojnacki, S.J. Conway, G. Cremonese, C.M. Dundas, M.R. El-Maarry, J. Fernando, C.J. Hansen, K. Hansen, T.N. Harrison, R. Henson, L. Marinangeli, A.S. McEwen, M. Pajola, S.S. Sutton, J.J. Wray (2017), Image simulation and assessment of the colour and spatial capabilities of the Colour and Stereo Surface Imaging System (CaSSIS) on the ExoMars Trace Gas Orbiter, *Space Sci. Rev.*, 214, 1, 18, 2018.
- Dundas, C.M., A.S. McEwen, S. Diniega, C.J. Hansen, **S. Byrne** & J.N. McElwaine (2017). The formation of gullies on Mars today. In: Conway, S. J., Carrivick, J. L., Carling, P. A., de Haas, T. & Harrison, T. N. (eds) *Martian Gullies and their Earth Analogues*. Geological Society, London, Special Publications, 467.
- Molaro, J.L., **S. Byrne**, and J.-L. Le, Thermally induced stresses in boulders on airless body surfaces, and implications for rock breakdown, *Icarus*, 294, 247-261, 2017.
- Schmidt, B.E., K. Hughson, H.T. Chilton, J.E. Scully, T. Platz, A. Nathues, H. Sizemore, M.T. Bland, **S. Byrne**, S. Marchi, D.P. O'Brien, N. Schorghofer, H. Hiesinger, R. Jaumann, D. Buzckowski, J.C. Castillo-Rogez, M.V. Sykes, P.M. Schenk, M.C. DeSanctis, G. Mitri, M. Formisano, J.-Y. Li, V. Reddy, L. LeCorre, C.T. Russell, and C.A. Raymond, Geomorphological evidence for ground ice on Ceres, *Nature Geoscience*, 10, 338–343, 2017.
- Sori, M.M., **S. Byrne**, M.T. Bland, A.M. Bramson, A.I. Ermakov, C.W. Hamilton, K.A. Otto, O. Ruesch, and C. T. Russell, The vanishing cryovolcanoes of Ceres, *Geophys. Res. Lett.*, 44, 1243–1250, 2017.
- Sori, M.M., J. Bapst, A.M. Bramson, **S. Byrne**, and M.E. Landis, A Wunda-full world? carbon dioxide ice deposits on Umbriel and other Uranian moons, *Icarus*, 290, 1-13, 2017.
- Becerra, P., M.M. Sori, and **S. Byrne**, Signals of astronomical climate forcing in the exposure topography of the North Polar Layered Deposits of Mars, *Geophys. Res. Lett.*, 43, 2017.
- Viola, D., A. S. McEwen, C. M. Dundas, and **S. Byrne**, Subsurface volatile content of martian double-layer ejecta (DLE) craters, *Icarus*, 284, 325-343, 2017.
- Titus, T.N., **S. Byrne**, A. Colaprete, F. Forget, T.I. Michaels and T.H. Prettyman, The CO₂ cycle, Cambridge University Press, Ed.s Haberle, Clancy, Forget, Smith and Zurek, Chapter 12, 2017.
- Forget, F., **S. Byrne**, J.W. Head, M.A. Mischna and N. Schörghofer, Recent climate variations, Cambridge University Press, Ed.s Haberle, Clancy, Forget, Smith and Zurek, Chapter 16, 2017.

- Platz, T., A. Nathues, N. Schorghofer, F. Preusker, E. Mazarico, S. E. Schroder, **S. Byrne**, T. Kneissl, N. Schmedemann, J.-P. Combe, M. Schafer, G. S. Thangjam, M. Hoffmann, P. Gutierrez-Marques, M. E. Landis, W. Dietrich, J. Ripken, K.-D. Matz, and C. T. Russell, Surface water-ice deposits in the northern shadowed regions of Ceres, *Nature Astronomy*, 1, 0007, 2016.
- Becerra, P., **S. Byrne**, M.M. Sori, S. Sutton, and K.E. Herkenhoff, Stratigraphy of the north polar layered deposits of Mars from high-resolution topography, *J. Geophys. Res. Planets*, 121, 1445-1471, 2016.
- Buczowski, D.L., B. E. Schmidt, D.A. Williams, S.C. Mest, J.E.C. Scully, A.I. Ermakov, F. Preusker, P. Schenk, K.A. Otto, H. Hiesinger, D. O'Brien, S. Marchi, H. Sizemore, K. Hughson, H. Chilton, M. Bland, **S. Byrne**, N. Schorghofer, T. Platz, R. Jaumann, T. Roatsch, M.V. Sykes, A. Nathues, M.C. De Sanctis, C.A. Raymond, and C.T. Russell, The geomorphology of Ceres, *Science*, 353, 4332, 2016.
- Combe, J.-P., T.B. McCord, F. Tosi, E. Ammannito, F.G. Carrozzo, M.C. De Sanctis, A. Raponi, **S. Byrne**, M.E. Landis, K.H.G. Hughson, C.A. Raymond, and C.T. Russell, Detection of local H₂O exposed at the surface of Ceres, *Science*, 353, 3010, 2016.
- Ruesch, O., T. Platz, P. Schenk, L.A. McFadden, J.C. Castillo-Rogez, L.C. Quick, **S. Byrne**, F. Preusker, D.P. O'Brien, N. Schmedemann, D.A. Williams, J.-Y. Li, M.T. Bland, H. Hiesinger, T. Kneissl, A. Neesemann, M. Schaefer, J.H. Pasckert, B.E. Schmidt, D.L. Buczowski, M.V. Sykes, A. Nathues, T. Roatsch, M. Hoffmann, C.A. Raymond, and C.T. Russell, Cryovolcanism on Ceres, *Science*, 353, 4286, 2016.
- Brown, A. J., W. M. Calvin, P. Becerra, and **S. Byrne**, Martian north polar cap summer water cycle, *Icarus*, 277, 401-415, 2016.
- Bierson, C.J., R.J. Phillips, I.B. Smith, S.E. Wood, N.E. Putzig, D. Nunes and **S. Byrne**, Stratigraphy and Evolution of the Buried CO₂ Deposit in the Martian South Polar Cap, *Geophys. Res. Lett.*, 43(9), 4172-4179, 2016.
- Landis, M.E., **S. Byrne**, I.J. Daubar, K.E. Herkenhoff and C.M. Dundas, A revised surface age for the North Polar Layered Deposits of Mars, *Geophys. Res. Lett.*, 43, 2016.
- Thompson, M.S., T.J. Zega, P. Becerra, J.T. Keane, **S. Byrne**, The Oxidation State of Nanophase Fe Particles in Lunar Soil: Implications for Space Weathering, *Meteoritics & Planetary Science*, 51(6), 1082-1095, 2016.
- Sori, M.M., **S. Byrne**, C.W. Hamilton, and M.E. Landis, Viscous flow rates of icy topography on the North Polar Layered Deposits of Mars, *Geophys. Res. Lett.*, 42, 2016.
- Daubar, I.J., C. Dundas **S. Byrne**, P. Geissler, G. Bart, A.S. McEwen, P.S. Russell, M. Chojnacki and M.P. Golombek, Changes in Blast Zone Albedo Patterns Around New Martian Impact Craters, *Icarus*, 267, 86-105, 2016.
- Dundas, C.M., **S. Byrne**, and A.S. McEwen, Modeling the development of martian sublimation thermokarst landforms, *Icarus*, 262, 154-169, 2015.

- Bramson, A.M., **S. Byrne**, N.E. Putzig, S. Sutton, J.J. Plaut, T.C. Brothers, and J.W. Holt, Widespread excess ice in Arcadia Planitia, Mars, *Geophys. Res. Lett.*, 42, 6566-6574, 2015.
- Becerra, P., **S. Byrne**, and A.J. Brown, Transient bright "halos" on the South Polar Residual Cap of Mars: Implications for mass-balance, *Icarus*, 251, 211-225, 2015.
- Hansen, C.J., S. Diniega, N. Bridges, **S. Byrne**, C. Dundas, A. McEwen, and G. Portyankina, Agents of change on Mars' northern dunes: CO₂ ice and wind, *Icarus*, 251, 264-274, 2015.
- Piqueux, S., **S. Byrne**, H.H. Kieffer, T.N. Titus, and C.J. Hansen, Enumeration of Mars years and seasons since the beginning of telescopic exploration, *Icarus*, 251, 332-338, 2015.
- Viola, D., A.S. McEwen, C.M. Dundas, and **S. Byrne**, Expanded secondary craters in the Arcadia Planitia region, Mars: Evidence for tens of Myr-old shallow subsurface ice, *Icarus*, 248, 190-204, 2015.
- Molaro, J.L., **S. Byrne**, and S.A. Langer, Grain-scale thermoelastic stresses and spatiotemporal temperature gradients on airless bodies, implications for rock breakdown, *J. Geophys. Res.*, 120, 255-277, 2015.
- Brown, A.J., T.I. Michaels, **S. Byrne**, W. Sun, T.N. Titus, A. Colaprete, M.J. Wolff, G. Videen and C.J. Grund, The Science Case for a Modern, Multi-Wavelength, Polarization-Sensitive LIDAR in Orbit around Mars., *Journal of Quantitative Spectroscopy and Radiative Transfer*, 153, 131-143, 2015.
- Daubar, I.J., C. Atwood-Stone, **S. Byrne**, A.S. McEwen, and P.S. Russell, The morphology of small fresh craters on Mars and the Moon, *J. Geophys. Res.*, 119, 2620-2639, 2014.
- Ojha, L., A.S. McEwen, C.M. Dundas, **S. Byrne**, S.S. Mattson, J.J. Wray, M. Masse and E. Schaefer, HiRISE Observations of Recurring Slope Lineae (RSL) during Southern Summer on Mars, *Icarus*, 231, 365-376, 2014.
- Dundas, C.M., **S. Byrne**, A.S. McEwen, M.T. Mellon, M.R. Kennedy, I.J. Daubar and L. Saper, HiRISE Observations of New Impact Craters Exposing Martian Ground Ice, *J. Geophys. Res.*, 109-127, 2014.
- McEwen, A.S., C.M. Dundas, S.S. Mattson, A.D. Toigo, L. Ojha, J.J. Wray, M. Chojnacki, **S. Byrne**, S.L. Murchie and N. Thomas, Recurring slope lineae in equatorial regions of Mars, *Nature Geoscience*, 7, 53-58, 2014.
- Christian, S., J.W. Holt, **S. Byrne** and K.E. Fishbaugh, Integrating Radar Stratigraphy with High Resolution Visible Stratigraphy of the North Polar Layered Deposits, Mars, *Icarus*, 226, 1241-1251, 2013.
- Clifford, S. M., K. Yoshikawa, **S. Byrne**, W. Durham, D. Fisher, F. Forget, M. Hecht, P. Smith, L. Tamppari, T. Titus, and R. Zurek, Introduction to the fifth Mars Polar Science special issue: Key questions, needed observations, and recommended investigations, *Icarus*, 225, 864-868, 2013.
- Hansen, C.J., **S. Byrne**, G. Portyankina, M. Bourke, C. Dundas, A. McEwen, M. Mellon, A. Pommerol and N. Thomas, Observations of the northern seasonal polar cap on Mars: I. Spring sublimation activity and processes, *Icarus*, 225, 881-897, 2013.

- Daubar, I., A. McEwen, **S. Byrne**, M. Kennedy and B. Ivanov, The Current Martian Cratering Rate, *Icarus*, 225, 506-516, 2013.
- Molaro, J., and **S. Byrne**, Rates of Temperature Change of Airless Landscapes and Implications for Thermal Stress Weathering, *J. Geophys. Res.*, 117, E10011, 2012.
- Caudill, C.M., L.L. Tornabene, A.S. McEwen, **S. Byrne**, L. Ojha and S. Mattson, Layered Megablocks in the Central Uplifts of Impact Craters, *Icarus*, 221, 710-720, 2012.
- Hvidberg, C.S., K.E. Fishbaugh, M. Winstrup, A. Svensson, **S. Byrne** and K. Herkenhoff, Reading the climate record of the Martian polar layered deposits, *Icarus*, 221, 405-419, 2012.
- Beyer, R.A., K.M. Stack, J.L. Griffes, R.E. Milliken, K.E. Herkenhoff, **S. Byrne**, J.W. Holt and J.P. Grotzinger, An Atlas of Mars Sedimentary Rocks as seen by HiRISE, Society for Sedimentary Geology Special Publication, 102, 49-96, 2012.
- Dundas, C.M., S. Diniega, C.J. Hansen, **S. Byrne** and A.S. McEwen, Seasonal Activity and Morphological Changes in Martian Gullies, *Icarus*, 220, 124-143, 2012.
- Sharma, P., and **S. Byrne**, Comparison of Titan's north polar lakes with terrestrial analogs, *Geophys. Res. Lett.*, 38, L24203, 2011.
- McEwen, A.S., and 9 colleagues, Seasonal Flows on Warm Martian Slopes, *Science*, 333, 740-743, 2011.
- Hansen, C.J., and 11 colleagues, Seasonal Erosion and Restoration of Mars' Northern Polar Dunes, *Science*, 331, 575-578, 2011.
- Phillips, R.J., and 17 colleagues, Massive CO₂ Ice Deposits Sequestered in the South Polar Layered Deposits of Mars, *Science*, 332, 838-841, 2011.
- Diniega, S., **S. Byrne**, N.T. Bridges, C.M. Dundas and A.S. McEwen, Seasonality of Present-day Martian Dune-Gully Activity, *Geology*, 38(11), 1047-1050, 2010.
- Sharma, P., and **S. Byrne**, Constraints on Titan's topography through fractal analysis of shorelines, *Icarus*, 209(2), 723-737, 2010.
- Banks, M.E., **S. Byrne**, K. Galla, A.S. McEwen, V.J. Bray, K.E. Fishbaugh, C.M. Dundas, K.E. Herkenhoff, B.C. Murray and the HiRISE Team, Crater Population and Resurfacing of the Martian North Polar Layered Deposits, *J. Geophys. Res.*, 115, E08006, 2010.
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- Dundas, C.M., and S. **Byrne**, Modeling Sublimation of Ice Exposed by Recent Impacts in the Martian Mid-Latitudes, *Icarus*, 206(2), 716-728, 2010.
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