

## *Curriculum Vitae: Michael W. Busch*

Updated July 3, 2012

### **Contact Information**

Email: [mbusch@cv.nrao.edu](mailto:mbusch@cv.nrao.edu) Telephone: 1-612-269-9998

Mailing Address:

National Radio Astronomy Observatory,  
P.O. Box O, 1003 Lopezville Rd.  
Socorro NM 87081, USA

### **Academic & Employment History**

Undergraduate:

BS Physics, University of Minnesota, awarded May 2005.

BS Astrophysics, University of Minnesota, awarded May 2005.

Graduate:

MS Planetary Science, Caltech, awarded June 2007.

PhD Planetary Science, Caltech, defended April 5, 2010.

Fannie and John Hertz Foundation Graduate Fellow, September 2007 to June 2010.

Postdoctoral Researcher, University of California Los Angeles, August 2010 – August 2011

Jansky Fellow, National Radio Astronomy Observatory, August 2011 – present.

### **Recent Publications:**

#### ***Papers***

Busch, M.W., and 12 colleagues, 2011. *Radar observations and the shape of near-Earth asteroid 2008 EV5*, Icarus 212, 649-660.

Busch, M.W., and 11 colleagues, 2012. *Arecibo/VLBA Radar Observations of Contact Binary Near-Earth Asteroid 2003 UV11*, **submitted to Icarus**.

Busch, M.W., Y. Takahashi, D.J. Scheeres, C. Magri, L.A.M. Benner, J.D. Giorgini, J.-L. Margot, R.S. Hudson, M.C. Nolan, 2012. *Twenty years of Toutatis: spin state changes and internal density variations*, **in prep**.

Busch, M.W., and 13 colleagues, 2012. *Radar imaging and the obliquity distribution of contact-binary near-Earth asteroids*, **in prep**.

Brozovic, M., and 19 colleagues, 2011. *Radar and optical observations and physical modeling of triple near-Earth asteroid (136617) 1994 CC*, Icarus 216, 241-256.

Haqq-Misra, J., Busch, M., Som, S., Baum, S., 2012. *The benefits and harms of transmitting into space*, Space Policy, **in press**.

#### ***Conference Presentations***

Busch, M.W., and 16 colleagues. *Shape and spin of near-Earth asteroid 308635 (2005 YU55) from radar images and speckle tracking*, 2012 ACM Meeting, Niigata, Japan.

Busch, M.W., L.A.M. Benner, D.J. Scheeres, C. Magri, Y. Takahashi, J.L. Margot, M.C. Nolan, J.D. Giorgini, *Twenty years of Toutatis*, 2011 DPS Meeting, Nantes, France.

Naidu, S.P., and 9 colleagues. *Binary near-Earth asteroid 2000 DP107: Component shapes, mutual orbit, and evolution*, 2011 DPS Meeting, Nantes, France.

## Full List of Publications

### *Journal Articles:*

- Busch, M.W., S.J. Ostro, L.A.M. Benner, J.D. Giorgini, R.F. Jurgens, R. Rose, C. Magri, P. Pravec, D.J. Scheeres and S.B. Broschart. 2006. *Radar and optical observations and physical modeling of near-Earth asteroid 10115 (1992 SK)*, Icarus, 181 145-155.
- Busch, M.W. 2006. *Feasibility of Asteroid Mining*, Society of Economic Geologists Newsletter, April 2006.
- Busch, M.W., S.J. Ostro, L.A.M. Benner, J.D. Giorgini, C. Magri, E.S. Howell, M.C. Nolan, A.A. Hine, D.B. Campbell, I.I. Shapiro, J.F. Chandler. 2007. *Arecibo Radar Observations of Phobos and Deimos*, Icarus, 186 581-584.
- Busch, M.W., S.R. Kulkarni, A.R. Conrad, P.B. Cameron. 2007. *Keck adaptive optics imaging of near-Earth asteroid 2004 XP14*, Icarus, 189 589-590.
- Busch, M.W., J.D. Giorgini, S.J. Ostro, L.A.M. Benner, R.F. Jurgens, M.D. Hicks, P. Pravec, P. Kusnirak, M.J. Ireland, D.J. Scheeres, S.B. Broschart, C. Magri, M.C. Nolan, A.A. Hine, J.-L. Margot. 2007. *Physical modeling of near-Earth asteroid (29075) 1950 DA*, Icarus 190 608-621.
- Busch, M.W., L.A.M. Benner, S.J. Ostro, J.D. Giorgini, R.F. Jurgens, R. Rose, D.J. Scheeres, C. Magri, J.-L. Margot, M.C. Nolan, A.A. Hine. 2008. *Physical properties of near-Earth asteroid (33342) 1998 WT24*, Icarus 195 614-621.
- Busch, M.W., O. Aharonson. 2008. *Measuring subsurface water distribution using the Dynamic Albedo of Neutrons Instrument on Mars Science Laboratory*, NIMA 592 393-399.
- Busch, M.W. 2008. *ALMA and Asteroid Science*, Icarus 200, 347-349.
- Busch, M.W., S.R. Kulkarni, A. Conrad. 2009. *No satellites around 21 Lutetia*, Icarus 203, 677-680.
- Busch, M.W., S.R. Kulkarni, W. Brisken, S.J. Ostro, L.A.M. Benner, J.D. Giorgini, M.C. Nolan. 2010. *Determining asteroid spin states using radar speckles*, Icarus 209, 535-541.
- Busch, M.W., S.J. Ostro, L.A.M. Benner, M. Brozovic, J.D. Giorgini, J.S. Jao, D.J. Scheeres, C. Magri, M.C. Nolan, E.S. Howell, P.A. Taylor, J.-L. Margot, W. Brisken, 2011. *Radar observations and the shape of near-Earth asteroid 2008 EV5*, Icarus 212, 649-660.
- Busch, M.W., R.M. Reddick. 2011. *Testing SETI message designs*, in "Communication With Extraterrestrial Intelligence", D.A. Vakoch editor, 419-423.
- Busch, M.W., and 11 colleagues, 2012. *Arecibo/VLBA Radar Observations of Contact Binary Near-Earth Asteroid 2003 UV11*, **submitted to Icarus**.
- Busch, M.W., Y. Takahashi, D.J. Scheeres, C. Magri, L.A.M. Benner, J.D. Giorgini, J.-L. Margot, R.S. Hudson, M.C. Nolan, 2012. *Twenty years of Toutatis: spin state changes and internal density variations*, **in prep**.
- Busch, M.W., and 13 colleagues, 2012. *Radar imaging and the obliquity distribution of contact-binary near-Earth asteroids*, **in prep**.
- Benner, L.A.M., S.J. Ostro, C. Magri, M.C. Nolan, E.S. Howell, J.D. Giorgini, R.F. Jurgens, J.-L. Margot, P.A. Taylor, M.W. Busch. 2008. *Near-Earth asteroid surface roughness depends on compositional class*, Icarus 198, 294-304.
- Brozovic, M., and 19 colleagues. 2011. *Radar and optical observations and physical modeling of triple near-Earth asteroid (136617) 1994 CC*, Icarus 216, 241-256.

- Giorgini, J.D., L.A.M. Benner, S.J. Ostro, M.C. Nolan, M.W. Busch. 2008. *Predicting the Earth encounters of (99942) Apophis*, Icarus 193 1-19.
- Haqq-Misra, J., Busch, M., Som, S., Baum, S., 2012. *The benefits and harms of transmitting into space*, Space Policy, *in press*.
- Magri, C., and 25 colleagues, 2010. *Radar and photometric observations and shape modeling of contact binary near-Earth asteroid (8567) 1996 HW1*, Icarus 214, 210-227.
- Ostro, S.J., Magri, C., Benner, L.A.M., Giorgini, J.D., Nolan, M.C., Hine, A.A., Busch, M.W., Margot, J.-L.. 2009. *Radar imaging of asteroid 7 Iris*, Icarus 207, 285-294.
- Shepard, M.K., J. Schlieder, B. Estes, C. Magri, M.C. Nolan, J.-L. Margot, S.J. Bus, E.L. Volquardsen, A. Rivkin, L.A.M. Benner, J.D. Giorgini, S.J. Ostro, M.W. Busch. 2006. *Radar, optical, and thermal observations of binary near-Earth asteroid 2002 CE26*, Icarus, 184 198-210.

#### **IAU Circulars:**

- Benner, L.A.M., J.D. Giorgini, S.J. Ostro, R.F. Jurgens, M.W. Busch, #8589: 2005 OE3
- Benner, L.A.M., J.D. Giorgini, S.J. Ostro, M.C. Nolan, M.W. Busch, #8711: (99942) Apophis
- Benner, L.A.M., S.J. Ostro, J.D. Giorgini, M.W. Busch, R. Rose, M.A. Slade, R.F. Jurgens, M.C. Nolan, A.A. Hine, G.J. Black, L.M. Carter, #8826: 2006 VV2
- Benner, L.A.M., S.J. Ostro, J.D. Giorgini, J. van Brimmer, L. Juare, J.S. Jao, R.F. Jurgens, M.A. Slade, M.W. Busch, #8866: 2007 DT103
- Giorgini, J.D., L.A.M. Benner, S.J. Ostro, M.C. Nolan, M.W. Busch, #8593: (99942) Apophis
- Nolan, M. C., E. S. Howell, L. A. M. Benner, S. J. Ostro, J. D. Giorgini, M. W. Busch, L. M. Carter, R. F. Anderson, C. Magri, D. B. Campbell, J. L. Margot, R. J. Vervack, Jr., M. K. Shepard, #8921: 2001 SN263

#### **Conference Presentations:**

- Busch, M.W., R.L. Lysak. *Auroral Ion Acceleration by Alfvén Waves*, SM21A-0450, 2004 Fall AGU Meeting, San Francisco, CA, USA.
- Busch, M.W., S.J. Ostro, L.A.M. Benner, J.D. Giorgini, R.F. Jurgens, C. Magri, P. Pravec, D.J. Scheeres, S.B. Broschart. *Radar observations and physical modeling of near-Earth asteroid 10115 (1992 SK)*, 2005 DPS Meeting, Cambridge, UK.
- Busch, M.W., J.D. Giorgini, S.J. Ostro, L.A.M. Benner, R.F. Jurgens, R. Rose, P. Pravec, D.J. Scheeres, S.B. Broschart, C. Magri, M.C. Nolan, A.A. Hine. *Physical Modeling of Near-Earth Asteroid 29075 (1950 DA)*, 2006 DPS Meeting, Pasadena, CA, USA.
- Busch, M.W., N.G. Heavens, B.J. Butler, S.R. Kulkarni, I.J. McEwan, M.I. Richardson. *Mars' L-band radio emission*, 2007 DPS Meeting, Pasadena, CA, USA.
- Busch, M.W., S.J. Ostro, S.R. Kulkarni, W. Briskin, M.C. Nolan. *Radar interferometric imaging of near-Earth objects*, 2008 DPS Meeting, Cornell, NY, USA.
- Busch, M.W., S.R. Kulkarni, S.J. Ostro, W. Briskin, L.A.M. Benner, M.C. Nolan, J.D. Giorgini, M. Brozovic, C. Magri, *Delay-doppler and radar-interferometric imaging of the near-Earth asteroid 2008 EV5*, 2009 DPS Meeting, Fajardo, PR, USA.
- Busch, M.W., S.J. Ostro, L.A.M. Benner, D.J. Scheeres, J.D. Giorgini, M. Brozovic, M.C. Nolan, E.S. Howell, P.A. Taylor, J.-L. Margot, C. Magri, J.S. Jao, W. Briskin, *Radar observations and the shape of 2008 EV5: ridges and craters on near-Earth asteroids*, 2010 DPS Meeting, Pasadena, CA, USA.

- Busch, M.W., L.A.M. Benner, D.J. Scheeres, C. Magri, Y. Takahashi, J.L. Margot, M.C. Nolan, J.D. Giorgini, *Twenty years of Toutatis*, 2011 DPS Meeting, Nantes, France.
- Busch, M.W., L.A.M. Benner, M. Brozovic, P.A. Taylor, M.C. Nolan, C. Magri, J.D. Giorgini, M.A. Slade, J.S. Jao, C.G. Lee, F.D. Ghigo, W.F. Brisken, J.L. Margot, S.P. Naidu, E.S. Howell, L.M. Carter, M.K. Shepard. *Shape and spin of near-Earth asteroid 308635 (2005 YU55) from radar images and speckle tracking*, 2011 ACM Meeting, Niigata, Japan.
- Benner, L.A.M., S.J. Ostro, J.D. Giorgini, M.W. Busch, R. Rose, J.S. Jao, R.F. Jurgens. *Radar Observations of Asteroid 2004 XP14: an Outlier in the Near-Earth Population*, 2006 DPS Meeting, Pasadena, CA, USA.
- Benner, L.A.M., M.W. Busch, M.C. Nolan, S.J. Ostro, J.D. Giorgini, R. Rose, J.S. Jao, G.J. Black, L.M. Carter, M.A. Slade, R.F. Jurgens, A.A. Hine. *Radar images of binary near-Earth asteroid 2006 VV2*, 2007 DPS Meeting, Orlando, FL, USA.
- Benner, L.A.M., M.C. Nolan, J.L. Margot, M. Brozovic, S.J. Ostro, M.K. Shepard, C. Magri, J.D. Giorgini, M.W. Busch. *Arecibo and Goldstone radar imaging of contact binary asteroids*, 2008 DPS Meeting, Cornell, NY, USA.
- Benner, L.A.M., M. Brozovic, J.D. Giorgini, M.C. Nolan, C. Magri, S.J. Ostro, J.S. Jao, K.J. Lawrence, J.-L. Margot, M.W. Busch, M.K. Shepard, E.S. Howell, P.A. Taylor, L.M. Carter. *Arecibo and Goldstone radar images of near-Earth asteroid (136849) 1998 CS1*, 2009 DPS Meeting, Fajardo, PR, USA.
- Brozovic, M., L.A.M. Benner, M.C. Nolan, E.S. Howell, C. Magri, J.D. Giorgini, P.A. Taylor, J.-L. Margot, M.W. Busch, M.K. Shepard, D.J. Scheeres, L.M. Carter. *Radar images and shape model of a triple asteroid (136617) 1994 CC*, 2010 DPS Meeting, Pasadena, CA, USA.
- Cook, A. M., M.K. Spencer, M.S. Avnet, J.A. Bonetti, K.L. Bryson, M.W. Busch, S.Y. Cheng, Z.A. Crawford, J.E. Edmunson, E.G. Fahnestock, C.R. Fuse, C.J. Hardgrove, C.A. Hier-Majumder, N.M. Johnson, J.A. Mikucki, L.J. Son, S.A. Wilson. *SCREAM (Subsurface Characterization Rover for Exobiology Assessment on Mars)*, 2006 DPS Meeting, Pasadena, CA, USA; 2006 Fall AGU Meeting, San Francisco, CA, USA; 2007 EGU Conference, Vienna, Austria.
- Giorgini, J.D., L.A.M. Benner, S.J. Ostro, M.C. Nolan, M.W. Busch. *The Earth encounters of Apophis in 2029 and 2036*, 2007 DPS Meeting, Orlando, FL, USA.
- Heavens, N.G., I.J. McEwan, M.W. Busch, C.E. Newman, M.I. Richardson. *Modeling and implications of exotic martian radio emission*, 2007 DPS Meeting, Orlando, FL, USA.
- Naidu, S.P., J.L. Margot, M.W. Busch, P.A. Taylor, M. Nolan, E. Howell, J.D. Giorgini, L.A.M. Benner, M. Brozovic, C. Magri. *Binary near-Earth asteroid 2000 DP107: Component shapes, mutual orbit, and evolution*, 2011 DPS Meeting, Nantes, France.
- Slade, M.A., C.G. Lee, J.S. Jao, L.A.M. Benner, Brozovic, M., J.D. Giorgini, M.W. Busch. *First results of the new Goldstone delay-Doppler radar chirp imaging system*, 2010 DPS Meeting, Pasadena, CA, USA.