

Chunhua Qi

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EDUCATION	California Institute of Technology, Pasadena, California Ph.D. in Planetary Science and minor in Astronomy. <ul style="list-style-type: none">• Dissertation Topic: “Aperture Synthesis Studies of the Chemical Composition of Protoplanetary Disks and Comets”• Advisor: <i>G.A. Blake</i> Peking University, Beijing, China B.S. in Space Physics		1995 - 2001 1990 - 1995
ACADEMIC EXPERIENCE	Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts Astrophysicist <ul style="list-style-type: none">• Observations of protoplanetary disks• Origin of the Solar System and comet studies Computer Engineer <ul style="list-style-type: none">• Designs, modifications, and maintenance of the MIR package, the off-line data calibration software for the Submillimeter Array. Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts SMA Postdoctoral Fellow <ul style="list-style-type: none">• Made the first SMA 345 GHz image. California Institute of Technology, Pasadena, California Research Assistant <ul style="list-style-type: none">• Millimeter interferometric studies of protoplanetary disks and comets• Database Maintenance, array operation for the Millimeter Array, the Owens Valley Radio Observatory		2003 - now 2000 - 2003 1995 - 2000
TEACHING EXPERIENCE	Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts Instructor for Harvard Astronomy course Astrophysics Lab (Ay191) California Institute of Technology, Pasadena, California Teaching Assistant <ul style="list-style-type: none">• Assisted in teaching graduate courses including Molecular Processes in Astronomy, Cosmochemistry and Atmospheric Chemistry.		2005 - 2007 1995 - 2000
PROFESSIONAL SOCIETIES AND SERVICES	Member of AAS (American Astronomical Society) and IAU (International Astronomical Union) and EAG (European Association of Geochemistry) Referee for The Astrophysical Journal and Astronomy & Astrophysics External Reviewer for NASA Exoplanet Research Program and NASA Postdoctoral Program and JCMT proposals		

LOC member for the conference “Submillimeter Astronomy
in the era of the SMA” (2005)

GRANTS

CO-PI: “The FUV Flux Irradiating the Surfaces of Protostellar Disks”
– NASA Hubble Space Telescope Cycle 11 Program (2002) PI: Nuria Calvet

PRESS RELEASE

CO snow line study:

- NRAO: <http://http://www.nrao.edu/pr/2013/snowline>
- ESO: <http://www.eso.org/public/news/eso1333>
- CfA: <https://www.cfa.harvard.edu/news/2013-20>

Comet study:

- CfA: <https://www.cfa.harvard.edu/news/2005-23>

INVITED TALKS AND
SEMINARS

2015 October 4–8, From clouds to protoplanetary disks: the astrochemical link, Berlin, Germany
“Chemical imaging of the CO snow line in protoplanetary disks”

2015 August 16–21, Goldschmidt 2015, Prague, CZ
“Gas distribution in protoplanetary disks”

2015 June 18–19, Frontiers in Star Formation: Celebrating Contributions to the Field by Nuria
Calvet and Lee Hartmann, Ann Arbor, MI, USA
“Molecules as diagnostic probes of disk structure”

2015 January 25–28, Revealing the Structure of Protoplanetary Disks, UNAM CRyA, Morelia,
Mexico
“Locating the CO Snow Line in Protoplanetary Disks”

2012 May 8–12, Revealing Evolution of Protoplanetary Disks in the ALMA Era, Kyoto, Japan
“Molecular Observations of Disks with the Submillimeter Array”

2011 March 14–16, Workshop on the Chemical Taxonomy of Comets, Annapolis, Maryland
“Interferometric Observations of Comets”

2010 May 17–19, Cometary Radio Astronomy Workshop, NRAO GBT
“Interferometric Imaging of the Outburst of Comet 17P/Holmes with the Submillimeter Array”

2010 March 17, Submillimeter and THz Astrochemistry, Tokyo, Japan
“Chemistry in Protoplanetary Disks - an Observational Perspective”

2009 October 1st, JPL Astrophysics Colloquium, Pasadena, CA

2007 June 22–24, The North American ALMA Science Center Conference: Through Disks to Stars
and Planets, Charlottesville, VA
“Chemistry in Disks – an Observational Perspective”

2006 July 16–23, 36th COSPAR Scientific Assembly, Beijing, China
“SMA Observation of Star-Forming Regions”

SELECTED
CONTRIBUTED
TALKS

2014 December 8–11, Revolution in Astronomy with ALMA, the 3rd Year, Tokyo, Japan
“Chemical Imaging of the CO Snow Line in Disks”

2013 June 3–7, IAUS 299: Exploring the Formation and Evolution of Planetary Systems, Victoria,
Canada
“Observational Signatures of the CO Snow Line in Protoplanetary Disks”

2012 June 10–15, The Origins of Stars and Their Planetary Systems, Hamilton, ON Canada
“Resolving the CO Snow Line in Protoplanetary Disks”

2011 May 22–26, AAS 218
“Resolving the CO Snow Line in the Disk around HD 163296”

2009 June 8–12, Millimeter and Submillimeter Astronomy at High Angular Resolution, Taipei, Taiwan

“An SMA View of Chemistry in Disks”

2005 June 13–16, Submillimeter Astronomy in the era of the SMA, Cambridge, MA

“Constraining TW Hydra Disk Properties”

REFEREED
PUBLICATIONS

Sixty-six papers in referred journals, including eleven as first author, with more than 3000 citations; h-index = 34 (source: Google Scholar by December 2015)

66. Flaherty, K. M., Hughes, A. M., Andrews, S. M., et al. 2016, “Resolved Gas Interior to the Dust Rings of the HD 141569 Disk”, *The Astrophysical Journal*, in press
65. Hogerheijde, M. R., Bekkers, D., Pinilla, P., et al. 2015, “Steepening of the 820 micron continuum surface-brightness profile signals dust evolution in TW Hya’s disk”, *The Astrophysical Journal*, in press
64. Guzmán, V. V., Öberg, K. I., Loomis, R., & Qi, C. 2015, “Cyanide Photochemistry and Nitrogen Fractionation in the MWC 480 Disk”, *The Astrophysical Journal*, **814**, 53
63. Qi, C., Öberg, K. I., Andrews, S. M., et al. 2015, “Chemical Imaging of the CO Snow Line in the HD 163296 Disk”, *The Astrophysical Journal*, **813**, 128
62. Kastner, J. H., Qi, C., Gorti, U., et al. 2015, “Rings of C₂H in the Molecular Disks Orbiting TW Hya and V4046 Sgr”, *IAU Symposium 314*, in press
61. Öberg, K. I., Furuya, K., Loomis, R., et al. 2015, “Double DCO⁺ Rings Reveal CO Ice Desorption in the Outer Disk Around IM Lup”, *The Astrophysical Journal*, **810**, 112
60. Rich, E. A., Wisniewski, J. P., Mayama, S., et al. 2015, “Near-IR Polarized Scattered Light Imagery of the DoAr 28 Transitional Disk”, *The astronomical Journal*, **150**, 86
59. Graninger, D., Öberg, K. I., Qi, C., & Kastner, J. 2015, “HNC in Protoplanetary Disks”, *The Astrophysical Journal*, **807**, L15
58. Espaillat, C., Andrews, S., Powell, D., Feldman, D., Qi, C., Wilner, D., D’Alessio, P. 2015, “The Transitional Disk around IRAS 04125+2902”, *The Astrophysical Journal*, **807**, 156
57. Aikawa, Y., Furuya, K., Nomura, H., & Qi, C. 2015, “Analytical Formulae of Molecular Ion Abundances and the N₂H⁺ Ring in Protoplanetary Disks”, *The Astrophysical Journal*, **807**, 120
56. Kastner, J. H., Qi, C., Gorti, U., Hily-Blant, P., Öberg, K., Forveille, T., Andrews, S., Wilner, D. 2015, “A Ring of C₂H in the Molecular Disk Orbiting TW Hya”, *The Astrophysical Journal*, **806**, 75
55. Öberg, K. I., Guzmán, V. V., Furuya, K., Qi, C., Aikawa, Y., Andrews, S.M., Loomis, R., Wilner, D.J. 2015, “The comet-like composition of a protoplanetary disk as revealed by complex cyanides”, *Nature*, **520**, 198
54. Favre, C., Bergin, E. A., Cleeves, L. I., Hersant, F., Qi, C., Aikawa, Y. 2015, “Evidence for DCO⁺ as a Probe of Ionization in the Warm Disk Surface”, *The Astrophysical Journal*, **807**, L23
53. Cleeves, L. I., Bergin, E. A., Qi, C., Adams, F. C., Öberg, K. I. 2015, “Constraining the X-Ray and Cosmic-Ray Ionization Chemistry of the TW Hya Protoplanetary Disk: Evidence for a Sub-interstellar Cosmic-Ray Rate”, *The Astrophysical Journal*, **799**, 204
52. Qi, C., Hogerheijde, M. R., Jewitt, D., Gurwell, M. A., & Wilner, D. J. 2015, “Peculiar Near-nucleus Outgassing of Comet 17P/Holmes during its 2007 Outburst”, *The Astrophysical Journal*, **799**, 110

51. Dutrey, A., Semenov, D., Chapillon, E., Gorti, U., Guilloteau, S., Hersant, F., Hogerheijde, M., Hughes, A.M., Meeus, G., Nomura, H., Pietu, V., Qi, C., Wakelam, V. 2014, "Physical and Chemical Structure of Planet-Forming Disks Probed by Millimeter Observations and Modeling", *Protostars and Planets VI*, 317
50. Favre, C., Cleeves, L. I., Bergin, E. A., Qi, C., & Blake, G. A. 2013, "A Significantly Low CO Abundance toward the TW Hya Protoplanetary Disk: A Path to Active Carbon Chemistry?", *The Astrophysical Journal*, **776**, L38
49. Rosenfeld, K. A., Andrews, S. M., Hughes, A. M., Wilner, D. J., & Qi, C. 2013, "A Spatially Resolved Vertical Temperature Gradient in the HD 163296 Disk", *The Astrophysical Journal*, **774**, 16
48. Qi, C., Öberg, K. I., Wilner, D. J., et al. 2013, "Imaging of the CO Snow Line in a Solar Nebula Analog", *Science*, **341**, 630
47. Qi, C., Öberg, K. I., Wilner, D. J., & Rosenfeld, K. A. 2013, "First Detection of $c\text{-C}_3\text{H}_2$ in a Circumstellar Disk", *The Astrophysical Journal*, **765**, L14
46. Qi, C., Öberg, K. I., & Wilner, D. J. 2013, "H₂CO and N₂H⁺ in Protoplanetary Disks: Evidence for a CO-ice Regulated Chemistry", *The Astrophysical Journal*, **765**, 34
45. Bergin, E. A., Cleeves, L. I., Gorti, U., Zhang, K., Blake, G.A., Green, J.D., Andrews, S.M., Evans, N. II, Henning, T., Oberg, K., Pontoppidan, K., Qi, C., Salyk, C., van Dishoeck, E. 2013, "An old disk still capable of forming a planetary system", *Nature*, **493**, 644
44. Rosenfeld, K. A., Qi, C., Andrews, S. M., Wilner, D.J., Corder, S.A., Dullemond, C.P., Lin, S., Hughes, A.M., D'Alessio, P., Ho, P.T.P. 2012, "Kinematics of the CO Gas in the Inner Regions of the TW Hya Disk", *The Astrophysical Journal*, **757**, 129
43. Öberg, K. I., Qi, C., Wilner, D. J., & Hogerheijde, M. R. 2012, "Evidence for Multiple Pathways to Deuterium Enhancements in Protoplanetary Disks", *The Astrophysical Journal*, **749**, 162
42. Espaillat, C., Ingleby, L., Hernández, J., Furlan, E., D'Alessio, P., Calvet, N., Andrews, S., Muzerolle, J., Qi, C., & Wilner, D. 2012, "On the Transitional Disk Class: Linking Observations of T Tauri Stars and Physical Disk Models", *The Astrophysical Journal*, **747**, 103
41. Andrews, S. M., Wilner, D. J., Hughes, A. M., Qi, C., Rosenfeld, K.A., Oberg, K.I., Birnstiel, T., Espaillat, C., Cieza, L.A., Williams, J.P., Lin, S., Ho, P.T.P. 2012, "The TW Hya Disk at 870 μm : Comparison of CO and Dust Radial Structures", *The Astrophysical Journal*, **744**, 162
40. Öberg, K. I., Qi, C., Wilner, D. J., & Andrews, S. M. 2011, "The Ionization Fraction in the DM Tau Protoplanetary Disk", *The Astrophysical Journal*, **743**, 152
39. Lyo, A.-R., Ohashi, N., Qi, C., Wilner, D. J., & Su, Y.-N. 2011, "Millimeter Observations of the Transition Disk around HD 135344B (SAO 206462)", *The Astronomical Journal*, **142**, 151
38. Qi, C., D'Alessio, P., Öberg, K. I., Wilner, D. J., Hughes, A. M., Andrews, S. M., & Sandra, A. 2011, "Resolving the CO Snow Line in the Disk around HD 163296", *The Astrophysical Journal*, **740**, 84
37. Hughes, A. M., Wilner, D. J., Andrews, S. M., Williams, J. P., Su, K. Y.L., Murray-Clay, R. A., & Qi, C. 2011, "Resolved Submillimeter Observations of the HR 8799 and HD 107146 Debris Disks", *The Astrophysical Journal*, **740**, 38
36. Öberg, K. I., Qi, C., Fogel, J. K. J., Bergin, E. A., Andrews, S. M., Espaillat, C., Wilner, D. J., Pascucci, I., Kastner, J. H. 2011, "Disk Imaging Survey of Chemistry with SMA. II. Southern Sky Protoplanetary Disk Data and Full Sample Statistics", *The Astrophysical Journal*, **734**, 98
35. Andrews, S. M., Wilner, D. J., Espaillat, C., Hughes, A. M., Dullemond, C. P., McClure, M. K., Qi, C., Brown, J. M. 2011, "Resolved Images of Large Cavities in Protoplanetary Transition Disks", *The Astrophysical Journal*, **732**, 42

34. Hughes, A. M., Wilner, D. J., Andrews, S. M., Qi, C., & Hogerheijde, M. R. 2011, "Empirical Constraints on Turbulence in Protoplanetary Accretion Disks", *The Astrophysical Journal*, **727**, 85
33. Andrews, S. M., Wilner, D. J., Hughes, A. M., Qi, C., & Dullemond, C. P. 2010, "Protoplanetary Disk Structures in Ophiuchus. II. Extension to Fainter Sources", *The Astrophysical Journal*, **723**, 1241
32. Rodriguez, D. R., Kastner, J. H., Wilner, D., & Qi, C. 2010, "Imaging the Molecular Disk Orbiting the Twin Young Suns of V4046 Sgr", *The Astrophysical Journal*, **720**, 1684
31. Öberg, K. I., Qi, C., Fogel, J. K. J., Bergin, E. A., Andrews, S. M., Espaillat, C., van Kempen, T. A., Wilner, D. J., Pascucci, I. 2010, "The Disk Imaging Survey of Chemistry with SMA. I. Taurus Protoplanetary Disk Data", *The Astrophysical Journal*, **720**, 480
30. Hughes, A. M., Andrews, S. M., Wilner, D. J., Meyer, M. R., Carpenter, J. M., Qi, C., Hales, A. S., Casassus, S., Hogerheijde, J. R., Mamajek, E. E., Wolf, S., Henning, T., Silverstone, M. D. 2010, "Structure and Composition of Two Transitional Circumstellar Disks in Corona Australis", *The Astronomical Journal*, **140**, 887
29. Brown, J. M., Blake, G. A., Qi, C., Dullemond, C. P., Wilner, D. J., & Williams, J. P. 2009, "Evidence for Dust Clearing Through Resolved Submillimeter Imaging", *The Astrophysical Journal*, **704**, 496
28. Andrews, S. M., Wilner, D. J., Hughes, A. M., Qi, C., & Dullemond, C. P. 2009, "Protoplanetary Disk Structures in Ophiuchus", *The Astrophysical Journal*, **700**, 1502
27. Panić, O., Hogerheijde, M. R., Wilner, D., & Qi, C. 2009, "A Break in the Gas and Dust Surface Density of the Disc around the T Tauri Star IM Lup", *Astronomy and Astrophysics*, **501**, 269
26. Hughes, A. M., Andrews, S. M., Espaillat, C., Wilner, D. J., Calvet, N., D'Alessio, P., Qi, C., Williams, J. P., Hogerheijde, M. R. 2009, "A Spatially Resolved Inner Hole in the Disk Around GM Aurigae", *The Astrophysical Journal*, **698**, 131
25. Hogerheijde, M. R., Qi, C., de Pater, I., Blake, G. A., Friedel, D. N., Forster, J. R., Palmer, P., Remijan, A. j., Snyder, L. E., Wright, M. C. H. 2009, "Simultaneous Observations of Comet C/2002 T7 (LINEAR) with the Berkeley-Illinois-Maryland Association and Owens Valley Radio Observatory Interferometers: HCN and CH₃OH", *The Astronomical Journal*, **137**, 4837
24. Panić, O., Hogerheijde, M. R., Wilner, D., & Qi, C. 2008, "Gas and Dust Mass in the Disc around the Herbig Ae Star HD 169142", *Astronomy and Astrophysics*, **491**, 219
23. Eisner, J. A., Plambeck, R. L., Carpenter, J. M., Corder, S. A., Qi, C., & Wilner, D. 2008, "Proplyds and Massive Disks in the Orion Nebula Cluster Imaged with CARMA and SMA", *The Astrophysical Journal*, **683**, 304
22. Qi, C., Wilner, D. J., Aikawa, Y., Blake, G. A., & Hogerheijde, M. R. 2008, "Resolving the Chemistry in the Disk of TW Hydrae. I. Deuterated Species", *The Astrophysical Journal*, **681**, 1396
21. Andrews, S. M., Hughes, A. M., Wilner, D. J., & Qi, C. 2008, "The Structure of the DoAr 25 Circumstellar Disk", *The Astrophysical Journal*, **678**, L133
20. Hughes, A. M., Wilner, D. J., Qi, C., & Hogerheijde, M. R. 2008, "Gas and Dust Emission at the Outer Edge of Protoplanetary Disks", *The Astrophysical Journal*, **678**, 1119
19. Brown, J. M., Blake, G. A., Qi, C., Dullemond, C. P., & Wilner, D. J. 2008, "LkH α 330: Evidence for Dust Clearing through Resolved Submillimeter Imaging", *The Astrophysical Journal*, **675**, L109
18. Espaillat, C., Calvet, N., D'Alessio, P., Hernández, J., Qi, C., Hartmann, L., Furlan, E., & Watson, D. M. 2007, "On the Diversity of the Taurus Transitional Disks: UX Tauri A and LkCa 15", *The Astrophysical Journal*, **670**, L135

17. Isella, A., Testi, L., Natta, A., Neri, R., Wilner, D., & Qi, C. 2007, "Millimeter imaging of HD 163296: probing the disk structure and kinematics", *Astronomy and Astrophysics*, **469**, 213
16. Qi, C. 2007, "The Submillimeter Array", *Advances in Space Research*, **40**, 639
15. Qi, C., Wilner, D. J., Calvet, N., Bourke, T. L., Blake, G. A., Hogerheijde, M. R., Ho, P. T. P., & Bergin, E. 2006, "CO J=6-5 observation of TW Hya with the SMA", *The Astrophysical Journal*, **636**, L157
14. Raman, A., Lisanti, M., Wilner, D. J., Qi, C., & Hogerheijde, M. 2006, "A Keplerian disk around the Herbig Ae star HD169142", *The Astronomical Journal*, **131**, 2290
13. Meech, K. J., and 208 coauthors including Qi C. 2005, "Deep Impact: Observations from a Worldwide Earth-Based Campaign", *Science*, **310**, 265
12. Luis A. Zapata, Luis F. Rodríguez, Paul T.P. Ho, Qizhou Zhang, Chunhua Qi, S.E. Kurtz 2005, "A Highly Collimated, Young, and Fast CO Outflow in OMC-1 South", *The Astrophysical Journal*, **630**, L85
11. Chunhua Qi, Paul Ho, David J. Wilner, Shigehisa Takakuwa, Naomi Hirano, Nagayoshi Ohashi, Tyler L. Bourke, Qizhou Zhang, Geoffrey A. Blake, Michiel Hogerheijde, Masao Saito, Minh Choi, & Ji Yang 2004, "Imaging the Disk around TW Hya with the Submillimeter Array", *The Astrophysical Journal*, **616**, L11
10. Shigehisa Takakuwa, Nagayoshi Ohashi, Paul T. P. Ho, Chunhua Qi, David J. Wilner, Qizhou Zhang, Tyler L. Bourke, Naomi Hirano, Minh Choi, & Ji Yang 2004, "Submillimeter Array Observations of L1551 IRS 5 in CS (J=7-6)", *The Astrophysical Journal*, **616**, L15
9. Yi-Jehng Kuan, Hui-chun Huang, Steven B. Charnley, Naomi Hirano, Shigehisa Takakuwa, David J. Wilner, Sheng-Yuan Liu, Nagayoshi Ohashi, Tyler L. Bourke, Chunhua Qi, Qizhou Zhang 2004, "Organic Molecules in Low-Mass Protostellar Hot Cores: Submillimeter Imaging of IRAS 16293-2422", *The Astrophysical Journal*, **616**, L27
8. Naomi Hirano, Hiroko Shinnaga, Dinh-V-Trung, David Fong, Eric Keto, Nimesh Patel, Chunhua Qi, Ken Young, Qizhou Zhang, & Junhui Zhao 2004, "High Velocity Bipolar Outflow and Disk-like Envelope in the Carbon Star V Hya", *The Astrophysical Journal*, **616**, L43
7. Young, K. H.; Hunter, T. R.; Wilner, D. J.; Gurwell, M. A.; Barrett, J. W.; Blundell, R.; Christensen, R.; Fong, D.; Hirano, N.; Ho, P. T. P., Liu, S.Y., Lo, K.Y., Martin, R., Matsushita, S., Moran, J.M., Ohashi, N., Papa, D.C., Patel, N., Patt, F., Peck, A., Qi, C., Saito, M., Schinckel, A., Shinnaga, H., Sridharan, T.K., Takakuwa, S., Tong, C.E., Trung, D.V. 2004, "Submillimeter Array Observations of CS J = 14-13 Emission from the Evolved Star IRC +10216", *The Astrophysical Journal*, **616**, L51
6. Edwin Bergin and Nuria Calvet, Michiael L. Sitko, Herve Abgrall, Paola D'Alessio, Gregory J. Herczeg, Evelyne Roueff, Chunhua Qi, David K. Lynch, Ray W. Russell, Suellen M. Braford, R. Brad Perry 2004, "A New Probe of the Planet-Forming Region in T Tauri Disks", *The Astrophysical Journal*, **614**, L133
5. Michiel R. Hogerheijde, Imke de Pater, Melvyn Wright, J.R. Forster, L. E. Snyder, A. Remijan, L. M. Woodney, M. F. A'Hearn, P. Palmer, Y.-J. Kuan, H.-C. Huang, G. A. Blake, Chunhua Qi, J. Kessler, S.-Y. Liu 2004, "Combined BIMA and OVRO Observations of Comet C/1999 S4(LINEAR)", *The Astronomical Journal*, **127**, 2406
4. Chunhua Qi, Jacqueline E. Kessler, David W. Koerner, Anneila I. Sargent, & Geoffrey A. Blake 2003, "Continuum and CO/HCO⁺ Emission from the Disk Around the T Tauri Star LkCa 15", *The Astrophysical Journal*, **597**, 986
3. Yuri Aikawa, Munetake Momose, Wing-Fai Thi, Gerd-Jan Van Zade lhoff, Chunhua Qi, Geoffrey A. Blake, & Ewine F. van Dishoeck 2003, "Interferometric Observations of Formaldehyde in the Protoplanetary Disk around LkCa 15", *Publications of the Astronomical Society of Japan*, **55**, 11

2. E. I. Chiang, M.K. Joung, M.J. Creech-Eakman, C. Qi, J. Kessler, G.A. Blake, & E.F. van Dishoeck 2001, "Spectral Energy Distributions of Passive T Tauri and Herbig Ae Disks: Grain Mineralogy, Parameter Dependences, and Comparison with ISO LWS Observations", *The Astrophysical Journal*, **547**,1077
1. Geoffrey A. Blake, Chunhua Qi, Michiel R. Hogerheijde, Mark A. Gurwell, & Duane O. Muhleman 1999, "Sublimation from Icy Jets as a Probe of the Interstellar Volatile Content of Comets", *Nature* **398**, 213.

TECHNICAL MEMO "The MIR Cookbook" Chunhua Qi 2004-2015, WWW: www.cfa.harvard.edu/~cqi/mircook.html
"Calibrating Dual Rx Polarization Data" Chunhua Qi & Ken Young 2015, Submillimeter Array
Technical Memo #160