Douglas N. Friedel

National Center for Supercomputing Applications
University of Illinois
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Education

University of Illinois — Urbana, IL
PhD., Astronomy — 1999-2005
Thesis: *3mm Spectral Line Surveys of the High Mass Star Forming Regions Sagittarius B2(N-LMH) and Orion-KL*

Clarkson University — Potsdam, NY
B.S., Physics — 1995-1999
B.S., Mathematics — 1995-1999
Graduated with Distinction

Certifications

Certificate in Software Engineering — 2018-present
University of Illinois

ITIL Foundation Certification — 2018

Certificate in Project Management — 2009
Parkland College

Professional Experience

Research Programmer — 2015-present
National Center for Supercomputing Applications, University of Illinois

- Developed, maintained, and updated codebase for the automated data reduction of Dark Energy Survey (DES) telescope data, including job submission and monitoring software, database interface code, and parallel processing modules.
- Converted entire pipeline framework codebase from Python 2 to Python 3.
- Created version of the pipeline framework which can run on any machine without the overhead needed by the DES production services.
- Developed automated procedures to archive raw and processed DES data to tape storage for disaster recovery.

Research Programmer — 2008-2016
Department of Astronomy, University of Illinois

- Member of a team which developed the ALMA Data Mining Toolkit ADMIT), for the creation and analysis of new science products from ALMA data.
- Conducted high spatial resolution studies of high mass star forming regions with the CARMA array in order to study their chemical distributions and physical conditions.
- Member of the Combined Array for Research in Millimeter-wave Astronomy (CARMA) Computing Working Group.
- Developed CADRE, the automated CARMA data reduction pipeline.
- Developed, maintained, and updated CARMA data flow and antenna control software.

Maintained CARMA proposal system web pages and database.
Local Friend of the Telescope for CARMA, acting as a liaison between the site and local users.

BIMA/CARMA Operator 2000-2015
Department of Astronomy, University of Illinois
Traveled to the array for week-long observing runs, including scheduling and running of projects, general maintenance, and troubleshooting.

CARMA Summer School Instructor 2010-2014
Combined Array for Research in Millimeter-wave Astronomy, Bishop, CA
Member of a team which instructed and advised students on observation and data reduction techniques, including topics of: antenna and interferometry theory, receiver design, correlators, polarization, calibration techniques, and obtaining and reducing their own data.

CARMA Postdoctoral Research Associate 2006-2008
Department of Astronomy, University of Illinois
Member of the CARMA Computing Working Group.
Developed the CARMA project database system used to schedule and track all CARMA observations.
Developed new MIRIAD tasks including a converter for MIRIAD to MIR format.
Local Friend of the Telescope for CARMA.
Conducted high spatial resolution studies of high and low mass star forming regions with the CARMA array in order to study their chemical distributions to gain insight into the formation mechanisms of the individual molecular species.

BIMA/CARMA Research Assistant 1999-2005
Department of Astronomy, University of Illinois
Developed the Variable Temperature and Outflow Velocity model for analyzing interferometric data from comets.
Conducted spectral line surveys of high mass star forming regions with both an interferometric array and single element telescope in order to obtain full spatial scale information for all detected transitions.
Conducted interferometric observations of comets to study the chemical properties of the early solar nebula.

BIMA Proposal Processor 1999-2004
Department of Astronomy, University of Illinois

MIRIAD System Manager 2004-2011
Department of Astronomy, University of Illinois
Managed MIRIAD data reduction software package on department systems.

Awards
Sigurds Arajas Memorial Award for Experimental Physics 1996

Computer Skills
Data Reduction and Visualization: MIRIAD, CASA, ImViz, DS9
Languages: Python, C++, Java, C, Perl, Fortran
Databases: Oracle, MySQL, DbXml

Frameworks and toolkits: Condor, Qt (Python and C++), CORBA, CAN Bus
Web: Qt for WebAssembly, PHP, HTML, JSP

Research Interests

Studying the origins of complex organic molecules in the interstellar medium and comets.
Spectral line analysis software.
Automated data reduction and analysis pipelines.

Representative Publications

Friedel, D. N. & Looney, L. W. 2017, "CARMA λ = 1 cm Spectral Line Survey of Orion-KL", *Astronomical Journal*, 154, 152

Friedel, D. N. 2013, "CADRE: CArma Data REduction pipeline", *Astronomy and Computing, 2, 74*

Friedel, D. N. & Widicus Weaver, S. L., "Complex Organic Molecules at High Spatial Resolution toward ORION-KL II: Kinematics", *Astrophysical Journal Supplements*, 201, 17

Widicus Weaver, S. L. & Friedel, D. N., "Complex Organic Molecules at High Spatial Resolution toward ORION-KL I: Spatial Scales", *Astrophysical Journal Supplements*, 201, 16

Friedel, D. N. & Widicus Weaver, S. L., "A High Spatial Resolution Study of the λ = 3 mm Continuum of Orion-KL", *Astrophysical Journal*, 742, 64

Friedel, D. N., Kemball, A., & Fields, B. D. 2011, "The Search for Extragalactic Lithium Hydride", *Astrophysical Journal, 738, 37*

Refereed Publications

Abbott, T. M. C., Abdalla, F. B., Allam, S., et al. 2018, "The Dark Energy Survey: Data Release 1", *Astrophysical Journal Supplements,* 239, 18

Morganson, E., Gruendl, R. A., Menanteau, F., et al. 2018, "The Dark Energy Survey Image Processing Pipeline", *Publications of the Astronomical Society of the Pacific*, 130, 074501

Friedel, D. N. & Looney, L. W. 2017, "CARMA λ = 1 cm Spectral Line Survey of Orion-KL", *Astronomical Journal*, 154, 152

Remijan, A. J., Snyder, L. E., McGuire, B. A., Kuo, H.-L., Looney, L. W., **Friedel, D. N.**, Golubiatnikov , G. Y., Lovas, F. J., Ilyushin, V. V., Alekseev, E. A., Dyubko, S. F., McCall, B. J. & Hollis, J. M. 2014, "Observational Results of a Multi-telescope Campaign in Search of Interstellar Urea [$(NH_2)_2CO$]", *Astrophysical Journal*, 783, 77

Friedel, D. N. 2013, "CADRE: The CArma Data REduction pipeline", *Astronomy and Computing, 2, 74*

Friedel, D. N. & Widicus Weaver, S. L. 2012, "Complex Organic Molecules at High Spatial Resolution toward ORION-KL II: Kinematics", *Astrophysical Journal Supplements*, 201, 17

Widicus Weaver, S. L. & **Friedel, D. N.** 2012, "Complex Organic Molecules at High Spatial Resolution toward ORION-KL I: Spatial Scales", *Astrophysical Journal Supplements*, 201, 16

Friedel, D. N. & Widicus Weaver, S. L. 2011, "A High Spatial Resolution Study of the λ = 3 mm Continuum of Orion-KL", *Astrophysical Journal*, 742, 64

Friedel, D. N., Kemball, A., & Fields, B. D. 2011, "The Search for Extragalactic Lithium Hydride", *Astrophysical Journal, 738, 37*

Neill, J. L., Steber, A. L., Muckle, M. T., Zaleski, D. P., Lattanzi, V., Spezzano, S., McCarthy, M. C., Remijan, A. J., **Friedel, D. N.**, Widicus Weaver, S. L., & Pate, B. H. 2011, "Spatial Distributions and Interstellar Reaction Processes", *Journal of Physical Chemistry A*, 115, 6472

Shiao, Y.-S., Looney, L. W., Remijan, A. J., Snyder, L. E., & **Friedel, D. N.** 2010, "First Acetic Acid Survey with CARMA in Hot Molecular Cores", *Astrophysical Journal*, 716, 286

Plambeck, R. L., Wright, M. C. H., **Friedel, D. N.**, Widicus Weaver, S. L., Bolatto, A. D., Pound, M. W., Woody, D. P., Lamb, J. W., & Scott, S. L. 2009, "Tracing the Bipolar Outflow from Orion Source I", *Astrophysical Journal*, 704, 25

Hogerheijde, Michiel R., Qi, Chunhua, de Pater, Imke, Blake, Geoffrey, A., **Friedel, D. N.**, Forster, J. R., Palmer, Patrick, Remijan, Anthony 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 CH_3OH", *Astronomical Journal*, 137,4837

Remijan, Anthony J., Milam, Stefanie N., Womack, Maria, Apponi, A. J., Ziurys, L. M., Wyckoff, Susan, A'Hearn, M. F., de Pater, Imke, Forster, J. R., **Friedel, D. N.**, Palmer, Patrick, Snyder, L. E., Veal, J. M., Woodney, L. M., & Wright, M. C. H. 2008, "The Distribution, Excitation, and Formation of Cometary Molecules: Methanol, Methyl Cyanide, and Ethylene Glycol", *Astrophysical Journal*, 689, 613

Friedel, D. N. & Snyder, L. E. 2008, "High Resolution λ=1mm CARMA Observations of Large Molecules in Orion-KL", *Astrophysical Journal*, 672, 962

Milam, Stefanie N., Remijan, Anthony J., Womak, Maria, Abrell, Leif, Ziurys, L. M., Wyckoff, Susan, Apponi, A. J., **Friedel, D. N.**, Snyder, L. E., Veal, J. M., Palmer, Patrick, Woodney, L. M., A'Hearn, Michael F., Forster, J. R., Wright, M. C. H., de Pater, I., Choi, S., & Gesmundo, M 2006, "Formaldehyde in Comets C/1995 O1 (Hale-Bopp), C/2002 T7 (LINEAR), and C/2001 Q4 (NEAT): Investigating the Cometary Origin of H_2CO", *Astrophysical Journal*, 649, 1169

Remijan, Anthony J., **Friedel, D. N.**, de Pater, Imke, Hogerheijde, M. R., Snyder, L. E., A'Hearn, M. F., Blake, Geoffrey A., Dickel, H. R., Forster, J. R., Kraybill, C., Looney, L. W., Palmer, Patrick, & Wright, M. C. H. 2006, "A Bima Array Survey of Molecules in Comets Linear (C/2002 T7) and Neat (C/2001 Q4)", *Astrophysical Journal*, 643, 567

Friedel, D. N., Snyder, L. E., Remijan, Anthony J., & Turner, B. E., 2005, "Detection of Interstellar Acetone Toward the Orion-KL Hot Core", *Astrophysical Journal Letters*, 632, L95

Friedel, D. N., Remijan, Anthony J., Snyder, L. E., A'Hearn, M. F., Blake, Geoffrey A., de Pater, Imke, Dickel, H. R., Forster, J. R., Hogerheijde, M. R., Kraybill, C., Looney, L. W., Palmer, Patrick, & Wright, M. C. H., 2005, "BIMA Array Detections of HCN in Comets LINEAR (C/2002 T7) and NEAT (C/2001 Q4)", *Astrophysical Journal*, 630, 623

Remijan, Anthony J., Wyrowski, Friedrich, **Friedel, D. N.**, Meier, D. S., & Snyder, L. E. 2005, "A Survey of Large Molecules toward the Protoplanetary Nebula CRL 618", *Astrophysical Journal*, 626, 233

Snyder, L. E., Lovas, F. J., Hollis, J. M., **Friedel, D. N.**, Jewell, P. R., Remijan, A., Ilyushin, V. V., Alekseev, E. A., & Dyubko, S. F. 2005, "A Rigorous Attempt to Verify Interstellar Glycine", *Astrophysical Journal*, 619, 914

Remijan, A., Shiao, Y.-S., **Friedel, D. N.**, Meier, D. S., Snyder, L. E. 2004, "A Survey of Large Molecules of Biological Interest Toward Selected High Mass Star Forming Regions", *Astrophysical Journal*, 617, 384

Remijan, A., Sutton, E. C., Snyder, L. E., **Friedel, D. N.**, Liu, S.-Y., & Pei, C.-C. 2004, "High-Resolution Observations of Methyl Cyanide (CH_3CN) toward the Hot Core Regions W51e1/e2", *Astrophysical Journal*, 606, 917

Friedel, D. N., Snyder, L. E., Turner, B. E., & Remijan, A. 2004, "A Spectral Line Survey of Selected 3 Millimeter Bands toward Sagittarius B2(N-LMH) Using the National Radio Astronomy Observatory 12 Meter Radio Telescope and the Berkeley-Illinois-Maryland Association Array. I. The Observational Data", *Astrophysical Journal*, 600, 243

Remijan, A., Snyder, L. E., **Friedel, D. N.**, Liu, S.-Y., & Shah, R. Y. 2003, "A Survey of Acetic Acid toward Hot Molecular Cores", *Astrophysical Journal*, 590, 314

Editorial Works

Astronomical Data Analysis Software and Systems XXII, San Francisco, **D. N. Friedel**, ed. (2013)

Invited Talks

Friedel, D. N. & Widicus Weaver, S. L. 2009, "High Resolution λ=3mm Studies of Organic Molecules in Orion-KL", *238th Meeting of the American Chemical Society*

Conference Proceedings

Friedel, D., Looney, L. W., Teuben, P. J., Pound, M. W., Rauch, K. P.; Mundy, L., Harris, R. J. & Xu, L. 2016, "Alma Data Mining Toolkit", *71st Internal Symposium on Molecular Spectroscopy*

Friedel, D., Looney, L., Xu, L., Pound, M. W., Teuben, P. J., Rauch, K. P., Mundy, L. & Kern, J. S. 2015, "ADMIT: Alma Data Mining Toolkit", *70th Internal Symposium on Molecular Spectroscopy*

Friedel, D., Looney, L., Corby, J. F. & Remijan, A. 2015, "CARMA 1cm Line Survey of Orion-KL", *70th Internal Symposium on Molecular Spectroscopy*

Friedel, D. N., Xu, L., Looney, L., Teuben, P. J., Pound, M. W., Rauch, K. P., Mundy, L. G. & Kern, J. S. 2015, "ADMIT: ALMA Data Mining Toolkit", *225th American Astronomical Society Meeting*

Friedel, D. 2014, "The Molecular Complexity of G34.3+0.2", 69*th Internal Symposium on Molecular Spectroscopy*

Friedel, D. N., Looney, L., Mundy, L., Pound, M. & Teuben, P. 2014, "The ALMA Data Mining Toolkit II: Using ADMIT on Data Mined from the ALMA Archive", *Astronomical Data Analysis Software and Systems XXIII*, San Francisco, N. Manset and P. Forshay, eds.

Teuben, P., Pound, M., Mundy, L., Looney, L. & **Friedel, D. N.** 2013, "The ALMA Data Mining Toolkit I: Archive Setup and User Usage", *Astronomical Data Analysis Software and Systems XXIII*, San Francisco, N. Manset and P. Forshay, eds.

Friedel, D. N., Looney, L., Mundy, L., Pound, M. & Teuben, P. 2013, "The ALMA Data Mining Toolkit II: Using ADMIT on Data Mined from the ALMA Archive", *Astronomical Data Analysis Software and Systems XXIII*, San Francisco, N. Manset and P. Forshay, eds.

Friedel, D. N. 2013, "The CARMA Data Reduction Pipeline", *Astronomical Data Analysis Software and Systems XXII*, San Francisco, D. N. Friedel, ed. 475, 177

Friedel, D. N. 2013, "Multi-Resolution Studies of Complex Molecules in High Mass Star Forming Regions", *68th International Symposium on Molecular Spectroscopy*

Friedel, D. 2013, "CADRE: CArma Data REduction pipeline", Astrophysics Source Code Library, 1303.017

Kuo, H.-L., Remijan, A. J., Snyder, L. E., Looney, L. W., **Friedel, D. N.**, Lovas, F. J., McCall, B. J., & Hollis, J. M. 2011, "Evidence for Spectral Linewidth Change with Telescope Beamwidth: Support for the Identification Of Interstellar Urea", *Midwest Astrochemistry Meeting 2011*

Friedel, D. N. & Widicus Weaver, S. 2011, "The Chemistry of High Mass Star Forming Regions with "Chemical Differentiation": Orion KL, W75N, & W3", *IAU Symposium*, 280. 163

Kuo, H.-L., Remijan, A. J., Snyder, L. E., Looney, L. W., **Friedel, D. N.**, Lovas, F. J., McCall, B. J., & Hollis, J. M. 2010, "Detection of Interstellar Urea", *Midwest Astrochemistry Meeting 2010*

Friedel, D. N. & Widicus Weaver, S. L. 2010, "The Chemistry of High Mass Star Forming Regions with "Chemical Differentiation": Orion KL, W75N, & W3", *Midwest Astrochemistry Meeting 2010*

Friedel, D. N. 2010, "Astrochemistry with the Upgraded Combined Array for Research in Millimeter-wave Astronomy", *65th International Symposium On Molecular Spectroscopy*

Kuo, H.-L., Snyder, L. E., **Friedel, D. N.**, Looney, L. W., McCall, B. J., Remijan, A. J., Lovas, F. J., & Hollis, J. M. 2010, "Detection of Interstellar Urea with CARMA", *65th International Symposium On Molecular Spectroscopy*

Friedel, D. N., Kemball, Athol, & Fields, Brian 2009, "Cosmological Nucleosynthesis: The Lithium Problem", *64th Ohio State University Symposium on Molecular Spectroscopy*

Kuo, H.-L., Snyder, L. E., **Friedel, D. N.**, Looney, L. W., McCall, B. J. Remijan, A. J., Lovas, F. J., & Hollis, J. M. 2009, "A Search for Interstellar Urea with CARMA", *64th Ohio State University Symposium on Molecular Spectroscopy*

Friedel, D. N. & Widicus Weaver, Susanna L. 2009, "The Origins of Ethyl Cyanide and Dimethyl Ether in the Interstellar Medium", *64th Ohio State University Symposium on Molecular Spectroscopy*

Friedel, D. N. & Widicus Weaver, Susanna L. 2008, "Probing the Chemical Complexity of High Mass Star Forming Regions", *63rd Ohio State University Symposium on Molecular Spectroscopy*

Shiao, Y.-S., Looney, L. W., Snyder, L. E., **Friedel, D. N.**, & Remijan, A. J. 2008, "An Acetic Acid Survey Toward High- and Low-Mass Star Forming Regions", *63rd Ohio State University Symposium on Molecular Spectroscopy*

Snyder, L. E., Kuo, H.-L., **Friedel, D. N.**, Looney, L. W., McCall, B. J., Remijan, A. J., Lovas, F. J., & Hollis, J. M. 2008, "Using a Search for Interstellar Urea to Test the Ability of CARMA to Detect New Molecules", *63rd Ohio State University Symposium on Molecular Spectroscopy*

Friedel, D. N. & Snyder, L. E. 2008, "CARMA Observations of Large Organic Molecules in Orion-KL", *211th Meeting of the American Astronomical Society*

Friedel, D. N. & Looney, L. W. 2007, "Astrochemistry with the Combined Array for Research in Millimeter-Wave Astronomy", *62nd Ohio State University Symposium on Molecular Spectroscopy*

Shiao, Y.-S., **Friedel, D. N.**, Remijan, A. J., Looney, L. W., & Snyder, L. E. 2007, "The First Acetic Acid Survey from CARMA", *62nd Ohio State University Symposium on Molecular Spectroscopy*

Friedel, D. N., Snyder, L. E., & Remijan, A. J. 2007, "The Kinematics of the Orion-KL Region from High Resolution CARMA Observations", *62nd Ohio State University Symposium on Molecular Spectroscopy*

Kuo, H.-L, **Friedel, D. N.**, Looney, L. W., Snyder, L. E., Widdicus Weaver, S. L., & McCall, B. J. 2007, "Preparation for the Astronomical Search for Protonated Methanol", *62nd Ohio State University Symposium on Molecular Spectroscopy*

Friedel, D. N., Snyder, L. E., & Remijan, A. J. 2007, "High Resolution CARMA Observations of Acetone [$(CH_3)_2CO$] in the Orion-KL Region", *62nd Ohio State University Symposium on Molecular Spectroscopy*

Friedel, D. N., Snyder, L. E., Remijan, Anthony J., & Turner, B. E. 2006, "Analysis of the 3 MM spectrum of

Orion-KL from the BIMA Array", *61st Ohio State University Symposium on Molecular Spectroscopy*

Shiao, Y.-S., Looney, L. W., **Friedel, D. N.**, Snyder, L. E., Sutton, E. C., "Increasing Sensitivity to Large Molecules: The Importance of Phase correction to Millimeter Arrays", *61st Ohio State University Symposium on Molecular Spectroscopy*

Friedel, D. N., Remijan, A., Snyder, L. E., A'Hearn, M. F., Blake, G. A., de Pater, I., Dickel, H. R., Forster, J. R., Hogerheijde, M. R., Kraybill, C., Looney, L. W., Palmer, P., & Wright, M. C. H. 2005, "BIMA Array observations of Comets LINEAR (C/2002 T7) and NEAT (C/2001 Q4)", *60th Ohio State University Symposium on Molecular Spectroscopy*

Friedel, D. N., Snyder, L. E., Turner, B. E., & Remijan A. 2005, "BIMA Array 3mm Spectral Line Survey of Orion-KL", *60th Ohio State University Symposium on Molecular Spectroscopy*

Remijan, A. J., Wyrowski, F., **Friedel, D. N.**, Meier, D. S., & Snyder, L. E. 2005, "Survey of Large Molecules Toward the Protoplanetary Nebula CRL 618", *60th Ohio State University Symposium on Molecular Spectroscopy*

Friedel, D. N., Remijan, A., Snyder, L. E., A'Hearn, M. F., Blake, G. A., de Pater, I., Dickel, H. R., Forster, J. R., Hogerheijde, M. R., Kraybill, C., Looney, L. W., Palmer, P., & Wright, M. C. H., 2004, "BIMA Array observations of Comets LINEAR (C/2002 T7) and NEAT (C/2001 Q4)", *36th Meeting of the Division of Planetary Sciences, American Astronomical Society*, 36, 2506

Remijan, A., Snyder, L. E., **Friedel, D. N.**, Veal, J. M., Palmer, Patrick, Woodney, L. M., A'Hearn, Michael F., Forster, J. R., Wright, M. C. H., & de Pater, I. 2004, "A BIMA Array Search for Biomolecules in Comet Hale-Bopp(C/1995 O1)", *36th Meeting of the Division of Planetary Sciences, American Astronomical Society*, 36, 3202

Kim, K.-T., Churchwell, E., **Friedel, D. N.**, & Sewilo, M. 2004, "Molecular Outflows from Massive Protostars", *59th Ohio State University Symposium on Molecular Spectroscopy*

Remijan, A., Sutton, E. C., Snyder, L. E., **Friedel, D. N.**, Liu, S.-Y., & Pei, C.-C. 2004, "High-Resolution Observations of Methyl Cyanide (CH_3CN) toward the Hot Core Regions W51e1/e2", *59th Ohio State University Symposium on Molecular Spectroscopy*

Friedel, D. N., Snyder, L. E., Turner, B. E., & Remijan, A. 2004, "A Spectral Line Survey of Selected 3 Millimeter Bands toward Sagittarius B2(N-LMH) Using the National Radio Astronomy Observatory 12 Meter Radio Telescope and the Berkeley-Illinois-Maryland Association Array. II. Data Analysis", *59th Ohio State University Symposium on Molecular Spectroscopy*

Remijan, A., Sutton, E. C., Snyder, L. E., **Friedel, D. N.**, Liu, S.-Y., & Pei, C.-C., 2004, "High-Resolution Observations of Methyl Cyanide (CH_3CN) toward the Hot Core Regions W51e1/e2", *204th Meeting of the American Astronomical Society*, 204, 6116

Friedel, D. N., Snyder, L. E., Turner, B. E., & Remijan, A. J. 2003, "A λ=3 mm Spectral Line Survey of Sagittarius B2(N-LMH) with the BIMA Array and NRAO 12 Meter Radio Telescope", *58th Ohio State University Symposium on Molecular Spectroscopy*

Snyder, L. E., Remijan, A. J., Lovas, F. J., **Friedel, D. N.**, & Liu, S.-Y. 2003, "Interstellar Urea [$(NH_2)_2CO$]", *58th Ohio State University Symposium on Molecular Spectroscopy*