COLLEGE *of* CHARLESTON

Dr. Jon Hakkila, Professor
Department of Physics and Astronomy
College of Charleston

Dr. Michael Auerbach, SSM Dean
Dr. George Hynde, Provost
College of Charleston

Dear Dr. Auerbach and Dr. Hynde,

I would like to request a full year's sabbatical leave for the 2012-13 academic year. The title of my proposal is "Gamma-Ray Bursts and SONG/mini-SONG". My sabbatical is requested to continue work on two active academic research projects: 1) the study of gamma-ray burst pulse properties, and 2) continued development of the U.S. telescopic network for the Stellar Observations Network Group (SONG).

I plan to use part of my sabbatical to continue collaborative research projects with other gamma-ray burst (GRB) astronomers, while simultaneously developing new ones. My research has focused on gamma-ray bursts since 1989, when I was a member of the Burst And Transient Source instrument team (this was an experiment that flew on NASA's Compton Gamma-Ray Observatory), and I have recently made discoveries pertaining to GRB pulses that have gained some international notoriety and interest.

During my sabbatical I also plan to continue my efforts on behalf of the College of Charleston to establish U.S. telescopes in the SONG and mini-SONG networks. SONG and mini-SONG will allow us to study stellar oscillations, search for extrasolar planets, monitor stellar and solar activity, search for afterglows to gamma-ray bursts, and observe stellar pulsations in open star clusters. I was invited to participate in SONG at the request of my former advisor at New Mexico State University several years ago, and I have spearheaded organizational activities for this project by representing U.S. participants, seeking out collaborators, proposing science goals, and facilitating communication.

Both my GRB studies and the SONG/mini-SONG projects involve international collaborations, and I hope to travel both within and outside of the United States to work with these collaborators. To this end, I have some travel money available from two current NASA grants (from the ADAP and AISRP programs). I also have access to my own grant indirect money that I have brought to the College over the past decade. I will of course also seek external travel funding, as well as sabbatical salary support.

Sincerely yours,

Jon Hakkila
October 14, 2011

Jon Hakkila – 2012-13 Sabbatical Proposal
"Gamma-Ray Bursts and SONG/mini-SONG"

Planned Activities

A. Gamma-Ray Burst Pulses

Gamma ray bursts (GRBs) are the most violent explosions in the Universe, releasing energy on timescales from milliseconds to hundreds of seconds equivalent to that which can be produced by directly converting the Sun's entire mass to energy using Einstein's relationship $E=mc^2$, or a million times the energy that the Sun will release by nuclear fusion over its ten billion year lifetime. Most of this immediately-released energy (the *prompt emission*) is in the form of gamma rays, with each *photon* (light particle) carrying roughly 60 million times the energy of a visible light photon. This form of energy release is not the signature of a typical *thermal* (cooling) process, but rather suggests a more exotic process, such as energy release via relativistic electron collisional cooling or cooling with the help of exceptionally strong magnetic fields. Furthermore, the process by which GRB energy is released is not *stochastic* (random in time), but is strongly ordered: most photons are clumped together in the form of *pulses*. When taken with observational evidence suggesting that GRB emission is beamed toward the observer and traveling at relativistic velocities greater than 0.9999 times the speed of light, theoretical models of GRB pulse structure indicates a release mechanism that occurs via relativistic shocks in a beamed jet. The energy to accelerate matter to this velocity itself requires an amazing energy stockpile.

GRBs have been divided into three classes based on their *durations*, *spectral hardnesses* (ratios of high-energy to low-energy emission), and *fluences* (time integrated fluxes). The Long GRB class makes up most GRBs, and bursts within it are characterized by long durations, bright fluences, and intermediate spectral hardnesseses. Short GRBs are short, faint, and hard. Intermediate GRBs are soft and have intermediate durations and fluences.

Long GRBs are believed to originate from *hypernova* explosions. These events, which are essentially beamed supernova explosions, represent the deaths of massive stars with rapidly rotating cores. Short GRBs are thought to originate from collisions between paired neutron stars as they undergo orbital decay. Intermediate GRBs may not represent a separate source population, but may instead result from systematic differences between faint Long GRBs relative to bright ones.

A recent analysis of archival BATSE GRBs (the Burst And Transient Source Experiment on NASA's Compton Gamma Ray Observatory) demonstrates that most observable pulse properties are highly correlated. One of the most important of these is the *lag* (the timescale on which low-energy pulse emission typically lags behind high-energy pulse emission), because lag is a known GRB *luminosity* (distance-corrected brightness) indicator, and because the GRB lag is obtained from the mixed lags of overlapping individual pulses. The pulse lag correlates with pulse duration, fluence, and *asymmetry* (pulse shape), and anti-correlates with *peak flux* (brightness measured on a timescale short relative to the burst duration) and hardness. Since pulse lag is a measure of pulse luminosity, all of these measured pulse properties are also luminosity indicators. Furthermore, the correlative nature of pulse properties suggest that underlying pulse physics is based on a simple model with few free parameters, and that pulse evolution represents an energy injection followed by a subsequent cooling and decay. Armed with this knowledge, the apparent complexity of GRB time and spectral structure can be more easily explained as a superposition of relatively simple pulse structures.

Correlated GRB pulse properties are even more ubiquitous than previously thought. Pulses obeying these same correlative behaviors have recently been observed in the *afterglow* phase. While the prompt emission physics is still not well understood, the afterglow is a shock heating of material far from the GRB progenitor that follows well-understood astrophysical mechanisms. The afterglow begins in the x-ray and cools through the ultraviolet, visible, infrared, and radio spectral regimes. From the afterglow, GRB environments and host galaxies are studied. *X-ray flares* appear to be a low-energy equivalent of the prompt GRB pulses; these flares obey similar correlations but also become weaker with time. There is evidence to suggest that long flares observed during the optical afterglow are even lower-energy counterparts of prompt pulses.

Since pulse analysis has such a great potential impact on understanding GRB physics, continued study of pulse properties is timely and important. I am involved in several projects pertaining to GRB pulse analysis that I would like to continue to pursue during a sabbatical leave. It is not known which of these projects will be most productive during the sabbatical, so I list six of the most important projects:

1. *GRB pulse catalog* – with the help of many students, over a five-year period, I have been compiling a GRB pulse catalog from BATSE observations. Currently, over 1400 pulses have been measured from over 600 GRBs. I would like to finish this catalog in the upcoming year and make it available to the GRB community.
2. *New techniques for extracting GRB pulses* – with collaborators at Cornell, the University of Chicago, and Duke, I am developing new Bayesian statistical methods for extracting properties of overlapping pulses. This three year project has been funded by NASA for $665,000.
3. *Properties of Intermediate GRBs* – I am currently collaborating with astronomers in Hungary to determine whether pulse evidence supports the idea that Intermediate GRBs belong to a separate source population.
4. *Properties of quiescent GRBs* – I am currently serving on a Master's thesis at the University of Houston and collaborating with an astronomer at NASA's Johnson Space Flight Center to study the properties of GRBs having *quiescent* periods during which no emission occurs. Since emission occurs only during pulses, quiescent periods are specialized cases representing large interpulse durations.
5. *GTAC (GRB Temporal Analysis Collaboration)* – I have recently become part of an international group that studies time series analysis and variability in GRBs.
6. *GRB population studies* – with collaborators at Cornell, I am involved in studying the space and luminosity distributions of GRBs belonging to different populations. Our analysis will allow us to better understand GRB classes. This three-year project is funded by NASA for $334,200.

B. The Stellar Oscillations Network Group (SONG)

Over the past few decades, observational astronomy has continued to move more into the realm of time-domain observations. Stars, once thought to be constant and non-varying, have almost all been found to be variable with modern photon-counting instrumentation coupled with better statistical data-reduction techniques. This has led to a new era in astrophysics in which almost all astronomical objects are recognized to be variable on some timescale. Some variability is cyclic (e.g. stellar pulsations and oscillations), some is chaotic (e.g. some variable stars, classical novae, active galactic nuclei), and some is transient (e.g. supernovae, gamma-ray bursts, Solar System debris). Since variability timescales range from less than milliseconds to more than tens of millions of years, and since even strong repetitive signals can be hidden within faint signals, telescopes are in high demand that have long observing times coupled with high cadence and high signal-to-noise ratios. At present, many telescopes having these characteristics are in orbit. Orbital telescopes are successful but are prohibitively expensive to build, launch, and use.

SONG (the Stellar Oscillations Network Group) is a network of planned eight one-meter ground-based telescopes, spanning enough longitude and latitude to form two whole-earth telescopes. Using the Earth's rotation to keep a telescope always trained on a target, SONG will be able to take high resolution spectra every few seconds for the six months or so that a bright star is on the same side of the Sun as the Earth. These observations will allow measurement of periodic stellar oscillation modes so accurately that stellar internal structures and thus ages can be measured; this is the only know way that stellar ages (fundamentally important parameters) can be obtained. A second goal of SONG observations is that they will allow limits to be placed on the numbers and masses of extrasolar planets orbiting these stars – SONG may provide the best limits yet to be on small planets orbiting nearby stars. By focusing on Galactic Center fields, SONG observations will also allow extrasolar planets to be discovered via *gravitational microlensing* (the bending of distant starlight as it passes by intervening planets). Additionally, SONG will be able to closely observe and track afterglows from selected GRBs as they decay, and can be used to test the hypothesis that optical flares are related to prompt GRB pulses.

Of the four northern required hemisphere telescopes, longitude coverage suggests that two SONG telescopes be located in the United States. The College of Charleston is directly involved in the development of these two planned U.S. SONG telescopes; we were brought into this project at the request of New Mexico State University (my alma mater). I, along with College of Charleston professor James Neff, have developed close collaborative ties with Danish astronomers building a SONG telescope in Spain's Canary Islands and with Chinese Astronomers planning to construct a telescope in western China. I was the U.S. representative who signed a tentative agreement with Denmark and China to pursue the SONG network, and I am a member of the international SONG Steering Committee. The Chinese government has supported SONG, with one caveat: they would like to have a secondary network of half-meter telescopes established at the SONG sites at Chinese expense. This network, currently referred to as "mini-SONG," would be primarily for making high cadence observations of stars in open clusters.

Development of a mini-SONG network is now proceeding in tandem with the SONG network.

Our United States SONG/mini-SONG team consists of astronomers from New Mexico State University, the National Solar Observatory, the High Altitude Observatory, Yale University, and the Ohio State University. In 2009 we submitted an NSF MRI[2] (Stimulus) proposal for $6 million to purchase two telescopes, spectrographs, and cameras (one to be located on Hawaii's Mauna Loa and the other to be located at New Mexico's Apache Point); this proposal was recommended for funding but was ultimately unsuccessful when Stimulus money ran out. We submitted a second MRI proposal in 2010 for $3.26 million for a single telescope to be located on Mauna Loa in Hawaii; this proposal was not recommended for funding on the basis of a few addressable comments. Dr. Neff took his sabbatical leave in Boulder, Colorado last year to work with members Meanwhile, our collaboration has continued to seek funding support and is working to improve our proposal. Formal discussion has occurred twice: once at the Third SONG Workshop in Beijing in 2010 and once at the Fourth SONG Workshop in Charleston (September 15-20, 2011, which was funded by a $28,645 NSF OISE grant secured by Jim Neff and me). Our next SONG proposal will be submitted to NSF's MRI program in January 2012 and will hopefully be funded during my sabbatical year. In this upcoming proposal, we plan to use an existing one-meter telescope at New Mexico State University's Apache Point Observatory, while asking NSF for a spectrograph. We will also address comments made by the 2010 review panel by demonstrating SONG's efficacy using early data collected by the Danish prototype.

Some of the tasks pertaining to SONG that I hope to undertake during my sabbatical leave include:

1. *Organizing the SONG network structure via the SONG Steering committee.*
2. *Establishing the first U.S. SONG telescope at New Mexico State University.*
3. *Finding U.S. partners to share SONG operating costs.*
4. *Discussing mini-SONG development with Chinese astronomers.*
5. *Work toward developing statistical tools to reduce signal-to-noise measurements in the search for extrasolar planets.*

Anticipated Outcomes

1. *Publications* – I hope to submit several publications during my sabbatical leave. One of these, the GRB pulse catalog, is a significant work in progress.
a. *GRB pulse catalog* – this catalog will contain work from the past five years done at the College of Charleston with the grant-funded support of many undergraduates.
b. Other GRB papers (based on successful results in some of the aforementioned planned projects).
c. SONG papers (I plan to explore some new data analysis techniques for time series data).

2. *SONG* – Provided we receive NSF funding, I plan to administer the grant for the SONG telescope, and I will work to involve more U.S. partner institutions in the SONG project. I plan to travel to New Mexico to help set up operations, and perhaps to Arizona to monitor construction of the spectrograph. I will also hold discussions with our U.S. partners and with the Chinese concerning establishment of a mini-SONG node at Apache Point in New Mexico.

3. *Grant Proposals* – I will try to submit additional grant proposals to NASA and NSF in order to receive more funding to support the aforementioned projects.

4. *Collaborations, Meetings, and Presentations*
a. GTAC – The Third GTAC meeting is scheduled to take place at George Washington University in summer 2012.
b. SONG – The Fifth SONG Workshop will be held in Tenerife in the Spanish Canary Islands in May 2013. Before then, there may also be an invited visit to the Chinese SONG observatory site, and a first light ceremony for the Danish SONG Telescope.
c. Chinese GRB pulse collaboration – I hope to establish some collaborative ties with Chinese GRB astronomers. Interestingly, besides our SONG collaborators, there are many Chinese astronomers working with gamma-ray burst prompt emission.
d. International Astronomical Union (IAU) meeting in Beijing – I hope to attend the IAU General Assembly in Beijing, China during August 2012.
e. Kavli Institute for Theoretical Physics (KITP) – I have applied to attend the Kavli Institute for Theoretical Physics at the University of California at Santa Barbara in fall 2012. The Institute meets for 2.5 months, but attendees can participate for shorter periods of time. The topic of this institute will be black holes, including those that form during the GRB process.
f. Los Alamos National Laboratory – I am probing the possibility of visiting Los Alamos National Labs for a time as part of my sabbatical leave.
g. Other possible sabbatical locations to visit – the University of Alabama in Huntsville, the Ohio State University, George Washington University, NASA's Goddard Space Flight Center, Cornell University, and institutions in Vietnam.

Jon Hakkila

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Education

New Mexico State University, Las Cruces, New Mexico (1980-81, 1983-86)
- **Ph.D.** Astronomy (physics minor), May 1986, "Statistical Properties of Barium Stars."
- **M.S.** Astronomy (physics minor), June 1985.

University of California at San Diego, La Jolla, California (1975-80)
- **B.A.** Physics, June 1980.
- **B.A.** English/American Literature, June 1980.

Employment

College of Charleston
Department of Physics and Astronomy (2000 - present),
(2000- present) - Chair and professor of physics and astronomy.

Minnesota State University, Mankato
Department of Physics and Astronomy (1995 - 2000),
Department of Mathematics, Astronomy, and Statistics (1986-95):
(1994-2000) - Professor of astronomy.
(1989-1994) - Associate professor of astronomy (tenured 1991).
(1986-1989) - Assistant professor of astronomy.

New Mexico State University, Department of Astronomy:
(1980-81, 1983-86) - Graduate student and astronomy research/teaching assistant.

Science Applications International Corporation, Comsystems Division:
(Sept. 1981-May 1983, Summer 1984) - Mathematical/scientific programmer/analyst.

University of San Diego, Department of Natural Sciences:
(Spring 1982, Spring 1983) - Lecturer of physics and astronomy.

University of California at San Diego, Physics Department:
(Spring 1979, Summer 1980) - Teaching assistant and engineering aid.

Los Alamos National Laboratory:
(1978-79, part time) - Technician I and II.

Awards, Memberships, and Elected Positions

Large Synoptic Survey Telescope, member of Information and Statistics Science Collaboration – 2010 to present.
Kepler KASC WG9 member – 2010 to present.
Stellar Oscillations Network Group (SONG) Steering Committee – 2010 to present.
Third SONG Workshop (Beijing, China) Scientific Organizing Committee – Jan. to Mar. 2010.
Chaired a session on Gamma-Ray Bursts at the 215th AAS Meeting in Washington, D.C., Jan 4, 2010.
NASA Swift Cycle 1 Guest Investigator Review Panel – 2004.
NSF Astronomy REU Panel – 2003.
Session Co-Chair, computational tools in astrophysics, SCI2002 conference in Orlando, Florida – July 2002.
Member International Astronomical Union (Commissions **26**, **33**, and **44**) - 1991 to present.
Member American Astronomical Society - 1983 to present (HEAD member 1995-present).
NASA National Virtual Observatory Advisory Panel – 2001- 2002.
By invitation, helped revise NASA/ASEE Summer Faculty and NASA JOVE programs - 1999.
NASA AISR Review Panel – 1999, 2000, 2004, 2005, 2007.

Graduate Physics Faculty, University of Alabama in Huntsville - 1994-1997.
Compton Observatory Cycle 8 Review Panel (assistant panel chair) - 1998.
Compton Observatory Cycle 7 Review Panel (assistant panel chair) - 1997.
Compton Observatory Cycle 5 Review Panel - 1995.
Compton Fellowship Review Panel - 1995.
Mankato State University Presidential Research Lecturer - 1994.
Most Appreciated Teacher Award for College of Natural Sci., Math., and Home Econ. -1988, 1993.
Mankato State Sigma Xi Keynote Lecturer - 1992.
Staff Member, MSU Valley Writing Workshop -1988 to1994.
Faculty Merit Award for College of Natural Sci., Math., and Home Econ. -1987.

Grants and Fellowships (all awards Hakkila PI unless otherwise indicated)

NSF OISE – International Plan and Workshops ($28,645) – 2011-12.
Univ. Alabama in Huntsville/NASA Space Missions course subcontract (Runyon PI: $10,000) – 2011-12.
Univ. Alabama in Huntsville/NASA Space Missions course subcontract (Runyon PI: $25,000) – 2010-11.
Univ. Alabama in Huntsville/NASA Space Missions course subcontract (Runyon PI: $7,500) – 2009-10.
NASA AISRP grant (T. Loredo, PI: $665,000) – 2009 to 2012.
NASA ADP grant (T. Loredo, PI: $334,200) – 2009 to 2012.
NASA SC Space Grant Palmetto Scholars grant ($21,200) – 2009.
NASA Swift Cycle 2 Guest Investigator ($29,886) – 2006.
NASA Swift Cycle 2 Co-Guest Investigator (T. W. Giblin, PI: $30,817) – 2006.
NSF REU Supplement ($6,007) – 2005/06
South Carolina NASA/EPSCoR grant ($26,255) - 2005.
NSF Extragalactic astronomy and cosmology: RUI proposal (T. W. Giblin, PI: $243,558) – 2004 to 2007.
South Carolina NASA/EPSCoR grant (T. Giblin, PI: $20,957) - 2003.
C of C Research Travel Grants/NASA SC Spacegrant for student travel to AAS meeting ($2,110) – 2003.
NSF Extragalactic astronomy and cosmology: RUI proposal ($130,279) – 2001 to 2004.
NASA BATSE 5B Catalog subcontract (unsolicited proposal - $6,600) – 2001.
NASA AISRP Investigator ($222,100) – 1999 to 2002.
Compton Observatory Cycle 8 Co-Guest Investigator (C.A. Meegan, PI: $5,000) - 1999.
NASA/ASEE Summer Faculty Fellow at NASA-MSFC at Huntsville, AL ($10,000) - 1998.
Compton Gamma-Ray Observatory Cycle 6 Guest Investigator ($40,006) - 1996.
Compton Observatory Cycle 6 Co-Guest Investigator (D. Hartmann, PI: $10,000) - 1996.
Compton Gamma-Ray Observatory Cycle 5 Guest Investigator ($40,000) - 1995.
National Research Council Senior Fellowship ($52,000) - 1994.
Compton Gamma-Ray Observatory Cycle 4 Guest Investigator ($0) - 1994.
JOVE Augmentation Grant ($20,000) - 1994-96.
Compton Gamma-Ray Observatory Phase 3 Guest Investigator ($50,962) - 1993.
MSU faculty improvement grant for interdisciplinary course design "Evolution I" ($1,200) - 1994.
Infrared observing at Wyoming Infrared Observatory and Mt. Lemmon, AZ funded by U. of Wyoming, U. of Minn., and MSU research grant ($1,719) - 1993; ($1,525) - 1992; ($1,498) - 1991.
MSU faculty improvement grant for faculty interdisciplinary workshop ($2,000) - 1993.
NASA travel grant ($500) - 1992.
Mankato State/NASA JOVE (JOint VEnture) Investigator ($60,500) - 1990 to 1993.
MSU Academic Affairs research grant ($3,000) -1992.
NASA/ASEE Summer Faculty Fellow at NASA-MSFC at Huntsville, AL ($10,000) - 1990.
NASA/ASEE Summer Faculty Fellow at NASA-MSFC at Huntsville, AL ($10,000) - 1989.
Infrared observing at Cerro Tololo, Chile funded by NOAO and MSU res. grant ($465) - 1986, 1987.

Publications

Undergraduate co-authors denoted by (*).

Journal Articles

1. "Unification of Pulses in Long and Short Gamma-Ray Bursts: Evidence from Pulse Properties and their Correlations", J. Hakkila and R. D. Preece (2011), Astrophys. Journal, 740, 111.

2. "Testing the Gamma-Ray Burst Pulse Start Conjecture", J. Hakkila and R. J. Nemiroff (2009), Astrophys. Journal 705, 372.

3. "Correlations Between Lag, Luminosity, and Duration in Gamma-Ray Burst Pulses", J. Hakkila, T. W. Giblin, J. P. Norris, P. C. Fragile, and J. T. Bonnell (2008), Astrophysical Journal Letters, 677, L81-L84.

4. "A Gamma-Ray Burst Database of BATSE Internal Luminosity Function and Spectral Lag Values", J. Hakkila, T. W. Giblin, K. C. Young*, and S. P. Fuller*, Christopher D. Peters*, Chris Nolan*, Sarah M. Sonnett*, David J. Haglin, and Richard J. Roiger (2007), Astrophysical Journal Supplement Series, 169, 62.

5. "Hydrology and Water Budget for a Forested Atlantic Coastal Plain Watershed", S.V. Harder*, D.M. Amatya, T.J. Callahan, C.C. Trettin, and J. Hakkila (2006), Journal of the American Water Resources Association, 43, pp. 563-575.

6. "A Simple Two-Parameter Characterization of Gamma-Ray Burst Time Histories", J. Hakkila & T. W. Giblin (2006), Astrophysical Journal, 646, 1086.

7. "A Tool for Public Analysis of Scientific Data", D. Haglin, R. Roiger, J. Hakkila, & T. W. Giblin (2005), Data Science Journal, 4, 39.

8. "Long-Lag, Wide-Pulse Gamma-Ray Bursts", J. P. Norris, J. T. Bonnell, D. Kazanas, J. D. Scargle, J. Hakkila, & T. W. Giblin (2005), Astrophysical Journal, 627, 324.

9. "Probing GRB Jet Structure from Prompt Emission", J. Hakkila, T. W. Giblin, K. C. Young*, D. J. Haglin, R. J. Roiger, J. P. Norris, & J. D. Bonnell (2005), Chinese Journal of Astronomy &Astrophysics, 5, 171.

10. "Quiescent Burst Evidence for Two Distinct Emission Components", J. Hakkila & T. W. Giblin, (2004) Astrophys. J. 610, 361.

11. "A Gamma-Ray Burst Rapid-Response Observatory in the US Virgin Islands", T. W. Giblin, J. E Neff, J. Hakkila, K. Davis*, & D. Hartmann (2004), Astronomische Nachrichten, 325, 670.

12. "Subgroups of GRBs", J. Hakkila, T. W. Giblin, R. J. Roiger, D. J. Haglin, W. S. Paciesas, & C. A. Meegan (2004), Baltic Astronomy, 13, 211.

13. "How Sample Completeness Affects Gamma-Ray Burst Classification", J. Hakkila, T. W. Giblin, R. J. Roiger, D. J. Haglin, W. S. Paciesas, & C. A. Meegan (2003), Astrophys. J., 582, 320-329.

14. "Gamma-Ray Burst Class Properties", J. Hakkila, D. J. Haglin, G. N. Pendleton, R. S. Mallozzi, C. A. Meegan, & R. J. Roiger (2000) Astrophys. J., 538, 165-180.

15. "The Fourth BATSE Burst Revised Catalog", W. S. Paciesas, C. A. Meegan, G. N. Pendleton, M. S. Briggs, C. Kouveliotou, T. M. Koshut, J. P. Lestrade, J. J. Brainerd, J. Hakkila, M. McCollough, W. Henze, R. D. Preece, R. S. Mallozzi, R. M. Kippen, V. Connaughton, and G. J. Fishman (1999), Astrophys. J. Suppl. Ser., 122, 465.

16. "A Computerized Model of Large-Scale Visual Interstellar Extinction", J. Hakkila, J. M. Myers(*), B. J. Stidham(*) & D. H. Hartmann (1997), Astron. J., 114, 2043-2053.

17. "Current BATSE Gamma-Ray Burst Catalog", C. A. Meegan, G. N. Pendleton, M. S. Briggs, C. Kouveliotou, T. M. Koshut, J. P. Lestrade, W. S. Paciesas, M. McCollough, J. J. Brainerd, J. Hakkila, W. Henze, R. D. Preece, R. S. Mallozzi, R. M. Kippen, V. Connaughton, and G. J. Fishman (1997), available at http://www.batse.msfc.nasa.gov/data/grb/catalog/

18. "The Internal Luminosity Distribution of Bright Gamma-Ray Bursts and Its Relation to Duration and Spectral Hardness", Horack, J. M. & Hakkila, J. (1997), Astrophys. J., 479, 371.

19. "The Identification of Two Different Spectral Types of Pulses in Gamma-Ray Bursts", G. N. Pendleton, W. S. Paciesas, M. S. Briggs, R. D. Preece, R. S. Mallozzi, C. A. Meegan, J. M. Horack, G. J. Fishman, D. L. Band, J. L., Matteson, R. T. Skelton, J. Hakkila, L. A. Ford, C. Kouveliotou, & T. M. Koshut (1997), Astrophys. J., 489, 175-198.

20. "Luminosity Distributions of Cosmological Gamma-Ray Bursts", J. Hakkila, C. A. Meegan, J. M. Horack, G. N. Pendleton, M. S. Briggs, R. S. Mallozzi, T. M. Koshut, R. D. Preece, &W. S. Paciesas, (1996), Astrophys. J. 462, 125-130.

21. "Analytic Constraints on Gamma-Ray Burst Luminosity Functions", J. M. Horack, J. Hakkila, A. G. Emslie, & C. A. Meegan (1996), Astrophys. J. 462, 131-135.

22. "The Intensity Distribution for Gamma-Ray Bursts Observed with BATSE", G. N. Pendleton, R. S. Mallozzi, W. S. Paciesas, M. S. Briggs, R. D. Preece, T. M. Koshut, J. M. Horack, C. A. Meegan, G. J. Fishman, J. Hakkila, & C. Kouveliotou (1996), Astrophys. J. 464, 606-615.

23. "The Third BATSE Gamma-Ray Burst Catalog", C. A. Meegan, G. N Pendleton, M. S. Briggs, C. Kouveliotou, T. M. Koshut, J. P. Lestrade, W. S. Paciesas, M. McCollough, J. J. Brainerd, J. M. Horack, J. Hakkila, W. Henze, R. D. Preece, R. S. Mallozzi &G. J. Fishman (1996), Astrophys. J. Supp. 106, 65-110 and at WWW site http://cossc.gsfc.nasa.gov/cossc/ batse/burstcatalog/3b_intro.html).

24. "Improved Limits on Gamma Ray Burst Repetition", M. Tegmark, D. H. Hartmann, M. S. Briggs, J. Hakkila, & C. A. Meegan (1996), Astrophys. J. 466, 757-763.

25. "Galactic Gamma-Ray Burst Models: Constraints on the Intrinsic Luminosity Function", J. Hakkila, C. A. Meegan, J. M. Horack, G. N. Pendleton, M. S. Briggs, W. S. Paciesas, & A. G. Emslie (1995), Astrophys. J. 454, 134-143.

26. "Are Galactic GRB Models Still an Option?", D. H. Hartmann, M. S. Briggs, G. N. Pendleton, & J. Hakkila (1995), Astrophys. Space Sci. 231, 361-368.

27. "Constraints on the Luminosities of Gamma-Ray Bursts", J. Hakkila, C. A. Meegan, J. M. Horack, G. J. Fishman, G. N. Pendleton, M. S. Briggs, W. S. Paciesas, & A. G. Emslie (1995), Astrophys. Space Sci. 231, 369-372.

28. "Selection Effects and Tests of Repetition (Clustering) in the BATSE 1B Catalog", J. Hakkila, V. C. Vo, C. A. Meegan, G. J. Fishman, J. M. Horack, D. H. Hartmann, G. N. Pendleton, M. S. Briggs, &W. S. Paciesas (1995), Astrophys. Space Sci. 231, 23-26.

29. "The Large-Scale Isotropy of Gamma-Ray Bursts", M. S. Briggs, W. S. Paciesas, G. N. Pendleton, G. J. Fishman, C. A. Meegan, R. B. Wilson, M. N. Brock, C. Kouveliotou, D. H. Hartmann, & J. Hakkila (1995), Astrophys. J. 459, 40-63.

30. "Constraints on Galactic Distributions of Gamma-Ray Burst Sources from BATSE Observations", J. Hakkila, C. A. Meegan, G. N. Pendleton, G. J. Fishman, R. B. Wilson, W. S. Paciesas, M. N. Brock, and J. M. Horack (1994), Astrophys. J. 422, 659-670.

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18. "Development of a Gamma-Ray Burst Automated Response and Remote 0.5 m Telescope at Eteleman Observatory at the University of the Virgin Islands", T. W. Giblin, J. E. Neff, J. Hakkila, D. M. Drost, & N. Andreasian-Thomas (2003), American Astronomical Society HEAD, 35, 16.19 (abstract).

19. "Fast Rise Exponential Decay (FRED) Gamma-Ray Bursts and the Fluence Duration Bias", K. C. Young(*), J. Hakkila & T. W. Giblin (2003), Bull. Amer. Astron. Soc. (abstract), 202.4506Y.

20. "The Internal Luminosity Functions of Long Gamma-Ray Bursts", A. D. Stallworth(*), J. Hakkila & T. W. Giblin (2003), Bull. Amer. Astron. Soc. (abstract), 202.4502S.

21. "How GRB Time Histories Relate to the Internal Luminosity Function", S. P. Fuller(*), J. Hakkila & T. W. Giblin (2003), Bull. Amer. Astron. Soc. (abstract), 202.4504F.

22. "The Internal Luminosity Functions of Short Gamma-Ray Bursts", A. J. Sprague(*), T. W. Giblin & J. Hakkila (2003), Bull. Amer. Astron. Soc. (abstract), 202.4505S.

23. "Spectral Properties of Post-Quiescent Emission of Gamma-Ray Bursts", T. M. Freismuth(*), T. W. Giblin & J. Hakkila (2003), Bull. Amer. Astron. Soc. (abstract), 202.4503F.

24. "Development of a Gamma-Ray Burst Automated Response and Remote 0.5 m Telescope at Eteleman Observatory at the University of the Virgin Islands", T. W. Giblin, J. E. Neff, J. Hakkila, D. M. Drost, & N. Andreasian-Thomas (2003), American Astronomical Society HEAD, 35, 16.19 (abstract).

25. "Spectral Properties of Quiescent Gamma-Ray Bursts", T. Giblin & J. Hakkila (2003), American Astronomical Society HEAD, 35, 16.21 (abstract).

26. "The Internal Luminosity Function of a Gamma-Ray Burst", A. Stallworth(*), J. Hakkila, T. Giblin (2002) South Carolina Academy of Science, Volume LXIV, p. 96 (abstract).

27. "Effects of Gamma-Ray Burst Brightness on Internal Luminosity Function Measurement", T. Freismuth(*), J. Hakkila, T. Giblin (2002) South Carolina Academy of Science, Volume LXIV, p. 65 (abstract).

28. "Correlations Between the Internal Luminosity Function and Properties of the Long Class of Gamma-Ray Bursts", S. Fuller(*), J. Hakkila, T. Giblin (2002) South Carolina Academy of Science, Volume LXIV, p. 66 (abstract).

29. "Possible Correlation Between the Internal Luminosity Function of a Gamma-Ray Burst and the Burst Morphology", M. Thompson(*), J. Hakkila, T. Giblin (2002) South Carolina Academy of Science, Volume LXIV, p. 101 (abstract).

30. "Correlations Between the Internal Luminosity Function and Properties of the Short Class of Gamma-Ray Bursts", A. Sprague(*), J. Hakkila, T. Giblin (2002) South Carolina Academy of Science, Volume LXIV, p. 95 (abstract).

31. "Effects of the Fluence-Duration Bias on FREDs (Fast Rise Exponential Decay Gamma-Ray Bursts)", K. Young(*), J. Hakkila, T. Giblin (2002) South Carolina Academy of Science, Volume LXIV, p. 105 (abstract) – Award-winning physics and astronomy presentation.

32. "Finding Gamma-Ray Burst Classes", J. Hakkila, T. Giblin, W. S. Paciesas, D. J. Haglin, R. J. Roiger (2001), South Carolina Academy of Science, Volume LXIII, p. 76 (abstract).

33. "A Systematic Search for Measurement Biases in Gamma-Ray Burst Pulse Durations", D. Timmons*, J. Hakkila (2001), South Carolina Academy of Science, Volume LXIII, p. 102 (abstract).

34. "A Summary of Biases in the BATSE Burst Trigger", C. A. Meegan, G. N. Pendleton, R. S. Mallozzi, J. Hakkila, A. Johnson (1999), American Astronomical Society, HEAD Meeting #31, #17.04 (abstract).

35. "Approaches to Gamma-Ray Burst Classification", J. Hakkila, D. J. Haglin, R. J Roiger, G. N. Pendleton, R. S. Mallozzi, & C. A. Meegan (1998), Astrophysics and Algorithms: a DIMACS Workshop on Massive Astronomical Data Sets, in press (abstract).

36. "Latest Results from BATSE on the Isotropy of Gamma-Ray Bursts", C. A. Meegan, M. S. Briggs, & J. Hakkila (1996), Bull. Amer. Astron. Soc. 28, 1409 (abstract).

37. "Constraints on the Barium Star Spatial Distribution and Luminosity Function", J. M. Myers(*), J. Hakkila (1996), Bull. Amer. Astron. Soc. 28, 835 (abstract).

38. "A Computerized Visual Interstellar Extinction Model: Preliminary Results", B. J. Stidham(*), J. M. Myers(*), R. L. Stepanek(*), & J. Hakkila (1996), Bull. Amer. Astron. Soc. 28, 832 (abstract).

39. "On the Distribution of Luminosity Within Cosmic Gamma-Ray Bursts", J. M. Horack, J. Hakkila, R. D. Preece, T. M. Koshut, & R. S. Mallozzi (1996), Bull. Amer. Astron. Soc. 28, 844 (abstract).

40. "A Computerized Spatial Model of Visual Interstellar Extinction", C. L. Frank(*) & J. Hakkila (1994), Bull. Amer. Astron. Soc. 26, 1213 (abstract).

41. "Comments on the Accuracy of Angular Clustering Tests Used to Study Repeating Gamma-Ray Bursts in BATSE Data", V. C. Vo*, J. Hakkila, L. M. Pearson, C. A. Meegan, D. H. Hartmann, J. M. Horack, G. J. Fishman, G. N. Pendleton, R. B. Wilson, M. N. Brock, W. S. Paciesas, & M. S. Briggs (1994), Bull. Amer. Astron. Soc. 26, 873 (abstract).

42. "Integral Moment Analysis of the BATSE Burst Intensity Distribution: Comments on Two-Population (Local Disk/Halo Plus Extended Halo) Models", B. A. Thompson*, J. Hakkila, V. C. Vo, C. A. Meegan, J. M. Horack, G. J. Fishman, G. N. Pendleton, R. B. Wilson, M. N. Brock, W. S. Paciesas, & M. S. Briggs (1994), Bull. Amer. Astron. Soc. 26, 874 (abstract).

43. "Further Constraints on Galactic Coronal Models of BATSE Gamma-Ray Bursts: (1) Limits on Local Group Member Contributions, and (2) Implications for Spiral Arm Plus Coronal Distributions" J. Hakkila, C. A. Meegan, J. M. Horack, G. J. Fishman, G. N. Pendleton, R. B. Wilson, M. N. Brock, W. S. Paciesas, & M. S. Briggs" (1994), Bull. Amer. Astron. Soc. 26, 881 (abstract).

44. "Photometric Effects of Binarity on Am Star Broadband Colors", J. G. Mayer(*) & J. Hakkila (1994), Bull. Amer. Astron. Soc. 26, 868 (abstract).

45. "A Statistical Analysis of the Wolf-Rayet Star Spatial Distribution and Luminosity Function: Preliminary Results" J. C. Hallum(*), J. Hakkila, & C. A. Meegan (1994), Bull. Amer. Astron. Soc. 26, 955 (abstract).

46. "A Statistical Analysis of the Barium Star Spatial Distribution and Luminosity Function: Preliminary Results" J. M. Myers(*), B. W. Mulligan(*), M. J. Johnson(*), J. Hakkila, & C. A. Meegan (1994), Bull. Amer. Astron. Soc. 26, 955 (abstract).

47. "A Statistical Analysis of the Type I Cepheid Spatial Distribution and Luminosity Function: Preliminary Results" P. T. Bennett(*), J. Hakkila, & C. A. Meegan (1994), Bull. Amer. Astron. Soc. 26, 955 (abstract).

48. "Nova Aquilae 1993" International Astronomical Union Circular 5817 (1993), C. E. Woodward, G.F. Lawrence, R.D. Gehrz, M. Creese(*) and J. Hakkila.

49. "A Reexamination of the Beta vs. (R-I) Diagram for Normal and Metallic-Lined A Stars", J. G. Mayer and J. Hakkila (1992), Bull. Amer. Astron. Soc. 24, 766 (abstract).

50. "Models of Spatial and Luminosity Distributions of Gamma-Ray Bursts Observed by BATSE", J. Hakkila and C. A. Meegan (1992), Bull. Amer. Astron. Soc. 23, 1323 (abstract).

51. "Near-Infrared Broadband Photometry of Am Stars", C. E. Woodward, J. Hakkila, G. F. Lawrence, and R. D. Gehrz (1992), Bull. Amer. Astron. Soc. 23, 1376 (abstract).

52. "Large-Scale Anisotropies in the Spatial Distributions of Am Stars and Ap Stars", J. S. Kendall(*) and J. Hakkila (1990), Bull. Amer. Astron. Soc. 22, 866 (abstract).

53. "Are the Barium and Am Stars Related?", J. Hakkila (1989), in Proceedings of IAU Colloquium No. 106: Evolution of Peculiar Red Giant Stars, ed. H. R. Johnson and B. Zuckerman (Cambridge: Cambridge University), p. 60 (abstract).

54. "Statistical Corrections for Some Distance-Limited Stellar Samples", J. Hakkila (1988), Bull. Amer. Astron. Soc. 20, 718 (abstract).

55. "The Absolute Magnitudes of the Barium Stars", J. Hakkila (1987), Bull. Amer. Astron. Soc.19, 702 (abstract).

56. "Statistical Properties of Barium Stars", J. Hakkila (1985), Bull. Amer. Astron. Soc. 17, 840 (abstract).

Oral Conference Presentations, Invited Talks, and Colloquia

1. "SONG and Mini-SONG Observations of GRB Pulsed Emission", presented September 17, 2011 at the 4th SONG Workshop in Charleston, South Carolina.

2. "Testing the Gamma-Ray Burst Pulse Paradigm", presented August 29, 2011 at the 2nd GTAC meeting at Los Alamos National Laboratories in Los Alamos, New Mexico.

3. "The Progenitor-Independent Nature of Gamma-Ray Burst Pulses", presented March 9, 2011 at Princeton's Wunch Seminar in Princeton, New Jersey.

4. "Evidence for Universal Gamma-Ray Burst Pulse Properties", presented March 8, 2011 at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

5. Why GRB Pulse *Rises* are Symptomatic of Relaxation Rather than of Energy Injection", presented March 5, 2011 at The Prompt Activity of Gamma-Ray Bursts in Raleigh, North Carolina.

6. "Testing the Gamma-Ray Burst Pulse Paradigm: Observations and Repercussions" presented November 25, 2010 at University College in Dublin, Ireland.

7. "SONG Targets of Opportunity: Searching for Pulses in Gamma-Ray Burst Afterglows" invited talk presented March 30, 2010 at the 3rd SONG Worskhop in Beijing, PRC.

8. "Correlations between Lag, Duration, Peak Luminosity, Hardness, and Asymmetry in Long GRB Pulses" Poster Award presentation made Oct. 22, 2008, at the 6th Huntsville Gamma-Ray Bust Workshop in Huntstville, Alabama.

9. "Gamma-Ray Bursts" presented April 18, 2002 by J. Hakkila at the University of South Carolina in Columbia, South Carolina.

10. "An Online ToolSHED for Gamma-Ray Burst Classification" presented November 30, 2001 by J. Hakkila at the South Carolina Astronomy Meeting in Columbia, South Carolina.

11. "Gamma-Ray Burst Classification" presented April 4, 2000 by J. Hakkila at the College of Charleston in Charleston, South Carolina.

12. "Gamma-Ray Burst Class Properties" presented March 22, 2000 at Brigham Young University in Provo, Utah.

13. "A Gamma-Ray Burst Tool SHED (SHell for Expeditions using Data mining)" presented September 28, 1999 at the Applied Information Systems Research Program 1999 Workshop in Boulder, Colorado.

14. "Properties of Gamma-Ray Burst Classes" presented October 19, 1999 at the Fifth Huntsville Gamma-Ray Burst Symposium in Huntsville, Alabama.

15. "A Gamma-Ray Burst Tool SHED (SHell for Expeditions using Data mining)" presented September 28, 1999 at the Applied Information Systems Research Program 1999 Workshop in Boulder, Colorado.

16. "Effects of Sky Exposure and Trigger Efficiency on BATSE Observations of Gamma-Ray Bursts" presented August 21, 1998 for the NASA/ASEE Summer Faculty Fellowship Program at Mashall Space Flight Center in Huntsville, Alabama.

17. "Approaches to Gamma-Ray Burst Classification" presented May 8, 1998 at the DIMACS Workshop on Astrophysics and Algorithms in Princeton, New Jersey.

18. "AI Analysis of BATSE Localizations/BATSE Trigger Efficiency" presented April 17, 1998 for the BATSE Science Team at Mashall Space Flight Center in Huntsville, Alabama.

19. "AI Classification of Gamma-Ray Bursts" presented November 12, 1997 for the Computer Science Department at Mankato State University in Mankato, Minnesota.

20. "The Gamma-Ray Burst Distance Scale and Constraints on GRB Luminosities" presented October 11, 1996 at South Dakota State University in Brookings, South Dakota.

21. "The Gamma-Ray Burst Distance Scale and Constraints on GRB Luminosities" presented October 4, 1996 at Northwestern University in Chicago, Illinois.

22. "Constraints on the Luminosities of Cosmological Gamma-Ray Bursts", presented October 26, 1995 at the 1995 Huntsville Gamma-Ray Burst Symposium in Huntsville, Alabama.

23. "Constraints on the Luminosities of Gamma-Ray Bursts", presented April 29, 1995 at the 29th ESLAB Symposium at ESTEC in Noordwijk, The Netherlands.

24. "Selection Effects and Tests of Repetition (Clustering) in the BATSE 1B Catalog", presented April 25, 1995 at the 29th ESLAB Symposium at ESTEC in Noordwijk, The Netherlands.

25. "Constraints on the Luminosities of Galactic Gamma-Ray Bursts", presented March 15, 1995 at the San Diego, California conference *High Velocity Neutron Stars and Gamma-Ray Bursts*.

26. "Gamma-Ray Bursts" on March 10, 1995 by J. Hakkila at the University of Memphis in Memphis, Tennessee.

27. "Gamma-Ray Bursts and the Milky Way: Old Paradigms Die Hard" presented April 18, 1994 as the Mankato State University Douglas R. Moore Faculty Research Lectureship.

28. "The Enigma of the Gamma-Ray Bursts" presented March 17, 1994 at South Dakota State University.

29. "Further Constraints on Galactic Coronal Models of BATSE Gamma-Ray Bursts: (1) Limits on Local Group Member Contributions, and (2) Implications for Spiral Arm Plus Coronal Distributions" presented January 1994 at the American Astronomical Society Meeting in Minneapolis, Minnesota.

30. "Additional Constraints on Galactic Coronal/Extended Halo Source Distributions from BATSE Observations", presented October 22, 1993 at the Second Huntsville Gamma-Ray Burst Workshop in Huntsville, Alabama.

31. "Two-Population Models of Gamma-Ray Bursts" presented July 19, 1993 at NASA's Marshall Space Flight Center.

32. "Constraints on Galactic Gamma-Ray Burst Models from BATSE Angular and Intensity Distributions", presented October 16, 1992 at the 1992 Compton Symposium at Washington University in St. Louis, Missouri.

33. "Galactic Models of Gamma-Ray Bursts" presented at the University of Wyoming, April 14, 1992, in Laramie, Wyoming.

34. "Preliminary Model Constraints on the Spatial and Luminosity Distributions of Gamma-Ray Bursts Observed by BATSE", presented October 16, 1991 at the First Huntsville Gamma-Ray Burst Workshop in Huntsville, Alabama.

35. "BATSE Analysis Techniques for Probing the GRB Spatial and Luminosity Distributions", presented October 18, 1991 at the First Huntsville Gamma-Ray Burst Workshop in Huntsville, Alabama.

36. "The Burst and Transient Source Experiment (BATSE) on NASA's Gamma Ray Observatory (GRO)" presented August 29, 1990 at New Mexico State University in Las Cruces, New Mexico.

37. "BATSE Software for the Analysis of the Gamma Ray Burst Spatial Distribution" presented August 23, 1990 as part of the NASA/ASEE Summer Faculty Fellowship Program at NASA's George C. Marshall Space Flight Center in Huntsville, Alabama.

38. "Monte Carlo Models and Analysis of Galactic Disk Gamma-Ray Burst Distributions" presented March 8, 1990 at the University of Minnesota in Minneapolis.

39. "Monte-Carlo Models and Analysis of Galactic Disk Gamma-Ray Burst Distributions" presented September 8, 1989 as part of the NASA/ASEE Summer Faculty Fellowship Program at NASA's George C. Marshall Space Flight Center in Huntsville, Alabama.

40. "Barium Star Ages from Kinematics and Spatial Distributions" presented April 8, 1989 to the University of Wisconsin at Madison Astronomy Department.

41. "Statistical Corrections to Barium Star Luminosities" presented March 31, 1989 to the Astronomy Division of NASA's George C. Marshall Space Flight Center in Huntsville, Alabama.

42. "The Absolute Magnitudes of the Barium Stars", presented June 16, 1987 at the joint American Astronomical Society/Canadian Astronomical Society Meeting in Vancouver, British Columbia, Canada.

43. "Statistical Properties of Barium Stars", presented January 5, 1986 at the American Astronomical Society Meeting in Houston, Texas.