Daniel A. Perley

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Education

University of California, Berkeley	Astrophysics	PhD	2011	
Dissertation: The Diverse Environments of Gamma-Ray Bursts				
Thesis Advisor: Joshua S. Bloom				
University of California, Berkeley	Astrophysics	MA	2006	
Cornell University	Physics	BA	2004	

Appointments

Marie Curie Fellow	Niels Bohr Institute	2015-2017
Senior Postdoctoral Scholar	Caltech	2014-2015
Hubble Fellow	Caltech	2011-2014
Graduate Student Researcher	UC Berkeley	2005-2011
Head Graduate Student Instructor	UC Berkeley	2005-2007
Graduate Student Instructor	UC Berkeley	2004-2007
Summer Research Intern	Center for Astrophysics	2003
Summer Programming Intern	NRAO-Socorro	2001-2002

Research Interests

- ► Gamma-ray bursts and relativistic transients
- ► Core-collapse supernovae
- ► Interstellar dust
- ► High-redshift galaxy evolution and cosmology
- ► Astronomical software development

Awards:

- ► 2011 UC Berkeley Uhl Prize (for top dissertation)
- ▶ 2011 American Astronomical Society Rodger Doxsey Prize (for top 10% of dissertations presented at an AAS meeting)
- ▶ 2006 UC Berkeley Teaching Effectiveness Award (top 14 student instructors campuswide)
- ► 2006 Outstanding Graduate Student Instructor Award (top student instructor in astronomy department)

Service:

- ► 2015: Proposal reviewer, NASA
- ▶ 2014: Co-organizer, Pasadena Postdoc Retreat conference
- ▶ 2013-2014: Organizer, Caltech Tea Talk seminar series
- ▶ 2013, 2014: Caltech Optical Observatories time allocation committee
- ▶ 2013: Spitzer Space Telescope proposal review committee
- ▶ 2011: Student representative, UC Berkeley faculty search
- ► 2009-2015: Referee for scientific journals (incl. ApJ, MNRAS, PASP, Nature, Science)

Accepted Funding Proposals (as PI or financial PI):

- ► 2015: Marie Curie fellowship (€200k)
- ► 2014: Chandra data analysis funding (\$18k)
- ► 2013: Spitzer data analysis funding (\$176k)
- ► 2013: Hubble data analysis funding (\$2.5k)
- ► 2012: Hubble data analysis funding (\$40k)
- ► 2012: Herschel data analysis funding (\$6k)
- ► 2011: Spitzer data analysis funding (\$5k)
- ► 2011: Hubble fellowship (\$360k)
- ► 2010: Spitzer data analysis funding (\$24k)
- ▶ 2009: American Astronomical Society Travel Grant (\$1k)

total: \$852k

Research Leadership Roles:

- ► 2012-2015: PI, Swift GRB Host Galaxy Legacy Survey (SHOALS)
- ► 2015: Project Scientist, Palomar 60-inch Telescope

Accepted Observing Proposals:

As PI:

Spitzer Space Telescope:

- ► Cycle 11 (292 hours P3) The Swift extended GRB host legacy survey
- ► Cycle 9 (224 hours) Spitzer observations of GRB hosts: a legacy approach
- ► Cycle 8 (19 hours) *Understanding high-redshift dust with GRB hosts*
- ► Cycle 7 (27 hours) The host galaxies of dust-obscured GRBs

Hubble Space Telescope:

- ► Cycle 20 (19 orbits) *Unveiling the dusty universe with host galaxies of obscured GRBs* Herschel Space Observatory:
- ► OT 2 (37 hours P2) A survey of the host galaxies of dust-obscured gamma-ray bursts Keck Observatory:
 - ► 2014B, 2015A (6 nights) The Swift GRB host galaxy legacy survey
 - ▶ 2013B, 2014A (6 nights) Quantifying the extreme hosts of extreme transients
 - ▶ 2013A (2 nights) The environmental dependence of high-redshift dust
 - ▶ 2013A (1 night) Metallicities of z>0.5 GRB host galaxies
 - ▶ 2012A, 2012B (6 nights) The redshifts of dust-obscured GRBs

Combined Array for Research in Millimeter Astronomy:

- ▶ 2012B-2014B (82 hours) Target of opportunity observations of GRB afterglows
- ► 2014A, 2014B (20 hours) *The death of stars: A mm-wave view of iPTF supernovae* Very Large Array:
 - ▶ 2015A (42 hours) The ULIRG population selected by gamma-ray bursts
 - ▶ 2014B (17 hours) Dusty, luminous galaxies hosting unobscured gamma-ray bursts
 - ▶ 2013A, 2014A (76 hours) The dust-unbiased SFRs of GRB-selected galaxies
 - ▶ 2011A, 2012A (42 hours) A new population of IR-luminous GRB host galaxies

Palomar Observatory:

- ▶ 2012B-2015A (up to 30 hours ToO) ToO observations of exceptional Swift GRBs
- ▶ 2013A, 2013B (2 nights) Quantifying the extreme hosts of extreme transients
- ▶ 2013A (2 nights) The stellar masses of $z\sim0.5$ GRB host galaxies

Caltech Submillimeter Observatory:

▶ 2010B, 2011B (8 half nights) Sub-mm observations of heavily obscured GRB host galaxies Lick 40-inch Nickel Telescope:

▶ 2010A-2011A (10 nights) - Field calibrations for GRB host galaxy imaging

As co-I (select list of projects with major involvement):

Chandra X-ray Observatory:

► Cycle 16 (120 ks) - Late-time observations of GRB130427A

<u>Very Large Telescope</u>:

- ► 2014B (12.5 hours, X-shooter) Completing a mass-limited sample of high-z GRB hosts Gran Telescopio Canarias:
- ► 2014A-2015B (10 nights) Connecting GRBs and the star-formation rate density Gemini Observatory:
 - ▶ 2014A (2 nights) Connecting GRBs and the star-formation rate density
 - ▶ 2006A-2015A (200+ hours) Exceptional Swift and Fermi GRBs

Keck Observatory:

- ► 2005B-2010B (30+ nights) GRB diversity in a cosmological context
- ▶ 2005B-2011A (ToO) Target of opportunity observations of GRB sources
- ► 2012A-2015A (30+ nights) Exploring a new phase space with PTF

Hubble Space Telescope:

- ► Cycle 22-23 (22 orbits) Explosions in real-time: UV flash spectroscopy of infant SNe
- ► Cycle 22 (4 orbits) The environments of the rarest and most energetic supernovae
- ► Cycle 22 (9 orbits) Characterizing new fast optical transients with HST
- ► Cycle 22 (20 orbits) GRB hosts and the search for missing star formation at high-z
- ► Cycle 22 (12 orbits) r-process kilonova emission accompanying short-duration GRBs
- ► Cycle 20-21 (33 orbits) *Unveiling the progenitors of the most luminous supernovae*
- ► Cycle 18 (87 targets) A public SNAPSHOT survey of gamma-ray burst host galaxies
- ► Cycle 18-22 (47 orbits) *Identifying and studying GRBs at very high redshifts*
- ► Cycle 17 (8 orbits DDT) When degenerate stars collide
- ► Cycle 17 (4 orbits DDT) *Unveiling the dusty starburst galaxy hosting GRB080607* Atacama Pathfinder Experiment:
- ► 2011A (45 hours) A paradigm change in our view of star formation probed by GRBs Very Large Array:
 - ▶ 2014A, 2014B (45 hours) Probing the composition of GRB jets with the VLA
 - ► 2015A (136 hours) Young SNe and relativistic explosions

Observing Experience:

On-site:

- ► Keck Observatory: 59 nights (LRIS, NIRC, NIRSPEC, MOSFIRE)
- ► Palomar Observatory 5m: 8 nights (DBSP, WIRC)
- ► Gemini Observatory: 2 nights (NIRI)
- ► Lick Observatory 3m: 10 nights (PFCam, GEMINI)
- ► Lick Observatory 1m: 10 nights (CCDCam)
- ► Caltech Submillimeter Observatory: 5 nights (SHARC2)
- ► CARMA: 3 weeks

Service mode (script setup):

- ► JVLA (wideband continuum)
- ► HST (19 orbits WFC3-IR)
- ► Gemini (NIRI & GMOS, numerous ToO requests)
- ► CARMA (numerous TOO requests)
- ▶ Palomar 60-inch (numerous ToO requests)

Software Developed:

- ▶ galaxybuilder, a population-synthesis multiwavelength (UV through radio) galaxy SED modeling and fitting code.
- ▶ LPIPE, a 100% fully-automated reduction pipeline for LRIS at Keck (functional with multiple cameras for both imaging and longslit spectroscopy modes; includes automated wavelength, photometric and spectroscopic calibrations and many other features)
- ▶ autoastrometry.py, a 100% fully-automated pattern-matching solver for optical images of unknown offset and rotation.
- ► GRBOX, a public PHP-driven interactive catalog of all localized GRBs since 1967.
- ▶ pzap, a percolation-based algorithm for flagging cosmic rays in deep-depleted CCD images in the presence of strong background variations and high background noise levels
- ▶ autophot, a powerful "convenience" tool for instantaneous aperture photometry of source(s) in CCD images (including catalog lookup and zeropoint calibration)
- ▶ lcurve, software for fitting the complex light curves of gamma-ray bursts

<u>Professional Presentations</u> (as presenting author)

Invited Talks:

- 2015 ► GRBs as Tools to Explore the Young Universe (Beijing, China)
- 2014 ► Palomar Transient Factory Summer School (Pasadena, CA)
 - ► UC Irvine Astrophysics Seminar (Irvine, CA)
 - ► Goddard Space Flight Center (Greenbelt, MD)
 - ► University of Washington (Seattle, WA)
 - ▶ Jet Propulsion Laboratory (Pasadena, CA)
- 2013 ► Hotwiring the Transient Universe (Santa Fe, NM)
 - ► Colloquium, Institute for Astronomy (Honolulu, Hawaii)
 - ► Galaxies Meet GRBs at Cabo de Gata, (Las Negras, Spain)
 - ► Gamma-Ray Bursts 2013 (Nashville, TN)
 - ► Colloquium, Caltech Astronomy Department
- 2012 ► GRBs in the Era of Rapid Followup (Liverpool, UK)

Other Talks:

- 2015 ► IAU Focus Meeting (Honolulu, HI)
 - ► Energetic Objects Seminar (Stockholm, Sweden)
 - ▶ DARK Cake Talk (Copenhagen, Denmark)
 - ► AAS Winter Meeting (Seattle, WA)
- 2014 ► Swift: 10 Years of Discovery (Rome, IT)
 - ► IPAC Seminar (Pasadena, CA)
 - ► UT Austin Extragalactic Seminar (Austin, TX)
 - ► Keck Science Meeting (Pasadena, CA)
 - ► UC Santa Barbara Astronomy Seminar (Santa Barbara, CA)
 - ► UC Berkeley Astronomy Lunch Seminar (Berkeley, CA)
 - ► STScI Seminar (Baltimore, MD)
 - ► Carnegie Lunch Seminar (Pasadena, CA)
 - ► AAS Winter Meeting (Washington, DC)
- 2013 ► The Life Cycle of Dust in the Universe (Taipei, Taiwan)
 - ▶ Palomar Transient Factory Science Meeting (Santa Barbara, CA)
 - ► Explosive Transients: Lighthouses of the Universe
 - ► Astronomy Seminar (Weizmann Institute for Science, Rehovot, Israel)
 - ► Cake Talk, Dark Cosmology Centre (Copenhagen, Denmark)

- ► Thüringer Landessternwarte Tautenburg (Jena, Germany)
- ► CARMA Symposium (Chicago, IL)
- 2012 ► Astronomy Seminar, UC Riverside (Riverside, CA)
 - ► ASTRON (Dwingeloo, Netherlands)
 - ► GRB 2012 (Marbella, Spain)
 - ► Gamma-Ray Bursts 2012 (Munich, Germany)
- 2011 ► Seminar, Infrared Processing and Analysis Center (Pasadena, CA)
 - ► Keck Science Meeting (Pasadena, CA)
 - ► Chemical Evolution of GRB Host Galaxies (Sesto, Italy)
 - ▶ Dissertation Talk, American Astronomical Society (Seattle, WA)
- 2010 ► OIR Seminar (Center for Astrophysics, Cambridge, MA)
 - ► YCAA Seminar, Yale University (New Haven, CT)
 - ► Astronomy Seminar, Princeton (Princeton, NJ)
 - ► Gamma-Ray Bursts 2010 (Annapolis, Maryland)
 - ► Space Telescope Science Institute (Baltimore, MD)
 - ► Goddard Space Flight Center (Greenbelt, MD)
 - ► Seminar, Max Planck Institute for Extraterrestrial Physics, (Garching, Germany)
 - ► Thüringer Landessternwarte Tautenburg (Jena, Germany)
 - ► Dark Cosmology Centre (Copenhagen, Denmark)
 - ► Astronomy Seminar, University of Leicester (Leicester, UK)
 - ► Seminar, Penn State University (State College, PA)
 - ▶ Deciphering the Ancient Universe with Gamma-ray Bursts (Kyoto, Japan)
- 2009 ► The Shocking Universe (Venice, Italy)
- 2008 ► Huntsville GRB Symposium 2008 (Huntsville, Alabama)
- 2007 ► Gamma-Ray Bursts 2007 (Santa Fe, New Mexico)
 - ► The Next Decade of GRB Afterglows (Amsterdam, Netherlands)

Teaching Experience:

- ► Astronomy 10, "Introduction to Astronomy" (3 semesters as GSI, incl. 2 as head GSI)
- ► Astronomy 12, "The Planets" (2 semesters as GSI, incl. 1 as head GSI)
- ► Astronomy 300, "Instructional Techniques in Astronomy" (1 semester as co-instructor) *Astronomy 300 is a course on teaching methods for incoming graduate students.*
- ► Extensive development of interactive student worksheets, still commonly in use in these classes.

Mentoring Experience:

Mohan Ganeshalingam (UC Berkeley graduate student mentoring program; 2006-2011) Adam Morgan (UCB student mentoring program plus further research mentoring; 2008-2014) Wenxiong Li (Caltech undergraduate summer student, 2014)

Outreach:

- ► Gave public lectures at Caltech on the discovery of SN2011fe (in M101) and of SN2014J (in M82) as part of public outreach events related to these supernovae.
- ► Volunteered as a judge at several high school science fairs, from the regional to international level.
- ▶ Ran a solar telescope viewing station for the general public during the 2012 transit of Venus and the 2012 annular Solar eclipse.
- ► Assisted at telescope-viewing "star parties" at UC Berkeley and at a middle school in Oakland.

- ▶ Wrote GRB information page for Google Sky.
- ► Assisted an Iraqi astronomy PhD student by providing computer code and advice.
- ▶ Dated (using a proper-motion astrometric technique I devloped) a series of old (c.1900) astronomical photographs to verify their authenticity for a San Francisco Museum of Modern Art special exhibition.
- ► Gave several public lectures to amateur astronomical organizations (East Bay Astronomical Society, Mount Diablo Astronomical Society) and other organizations (Pixar Studios)
- ▶ Rewrote (essentially from scratch) the English Wikipedia article on gamma-ray bursts in 2006 and again in 2009. An editorial review designated it as a featured article, a title awarded to "the best articles in Wikipedia, as determined by Wikipedia's editors"; it was featured on Wikipedia's front-page as the cover article in June 2011.

Publications

Total refereed publications: 96 (+10 submitted)
Total citations: 4475 (5090 including nonrefereed)

h-index: 38 (or, counting only papers as 1st, 2nd, 3rd, or 4th author: 23)

(First author: 13 papers, 597 citations)

- ▶ Perley, Tanvir, Hjorth et al. 2015 The Swift GRB Host Galaxy Legacy Survey II. Spitzer 3.6µm Photometry and Evidence for a Near-Solar Metallicity Threshold (ApJ submitted)
- ▶ Perley, Krühler, Schulze et al. 2015 The Swift Gamma-Ray Burst Host Galaxy Legacy Survey I. Sample Selection and Redshift Distribution (ApJ submitted)
- ▶ Perley, Perley, Hjorth et al. 2015 Connecting GRBs and ULIRGs: A Sensitive, Unbiased Survey for Radio Emission from GRB hosts at 0<z<2.5 (ApJ 801:102)
- ▶ Perley, Cenko, Corsi, Tanvir et al. 2014 *The Afterglow of GRB 130427A from 1 to 10*^16 GHz (ApJ 781:37)
- ▶ Perley & Perley 2013 Radio Constraints on Obscured Star-Formation within Dark Gamma-Ray Burst Host Galaxies (ApJ 778:172)
- ▶ Perley, Levan, Tanvir, Cenko et al. 2013 A Population of Massive, Luminous Galaxies Hosting Heavily Dust-Obscured Gamma-Ray Bursts: Implications for the Use of GRBs as Tracers of Cosmic Star Formation (ApJ 778:128)
- ▶ Perley, Modjaz, Morgan, Cenko et al. 2012 The Luminous Infrared Host Galaxy of Short-duration GRB 100206A (ApJ 758:122)
- ▶ Perley, Morgan, Updike, Yuan et al. 2011 Monster in the Dark: The Ultraluminous GRB 080607 and its Dusty Environment (AJ 141:36)
- ▶ **Perley**, Bloom, Klein, Covino et al. 2010 *Evidence of Supernova-Synthesized Dust from the Afterglow of GRB 071025 at z=5* (MNRAS, 406:2473-2487)
- ▶ Perley, Cenko, Bloom, Chen et al. 2009 The Host Galaxies of Swift Dark Gamma-Ray Bursts: Observational Constraints on Highly Obscured and Very High-Redshift GRBs (AJ 138:1690-1708)
- ▶ Perley, Metzger, Granot, Butler et al. 2009 GRB 080503: Implications of a Naked Short Gamma-Ray Burst Dominated by Extended Emission (AJ 696:1871-1885)
- ▶ Perley, Li, Chornock, Prochaska et al. 2008 GRB 071003: Broadband Follow-up Observations of a Very Bright Gamma-Ray Burst in a Galactic Halo (ApJ 688:470-490)
- ▶ Perley, Bloom, Butler, Pollack et al. 2008 *The Troublesome Broadband Evolution of GRB 061126: Does a Gray Burst Imply Gray Dust?* (ApJ 672:449-464)

(Second author: 8 papers, 330 citations)

- ► Hashimoto, **Perley**, Ohta, Aoki et al. 2015 *The Redshift and Metallicity of the Host Galaxy of Dark GRB 080325 at z=1.78* (ApJ accepted)
- ▶ Morgan, Perley, Cenko, Bloom et al. 2014 Evidence for Dust Destruction from the Earlytime Colour Change of GRB 120119A (ApJ 440:1810)
- ► Chen, **Perley**, Wilson, Cenko et al. 2010 *A Mature Dusty Star-Forming Galaxy Hosting GRB 080607 at z=3.036* (ApJL 723:218)
- ▶ Bloom, **Perley**, Li, Butler et al. 2009 *Observations of the Naked-Eye GRB 080319B: Implications of Nature's Brightest Explosion* (ApJ 691:723-737)
- ► Chen, **Perley**, Pollack, Prochaska et al. 2009 *High-Redshift Starbursting Dwarf Galaxies Revealed by Gamma-Ray Burst Afterglows* (ApJ 691:152-174)
- ▶ Bloom, **Perley**, Chen, Butler et al. 2007 A Putative Early-Type Host Galaxy for GRB 060502B: Implications for the Progenitors of Short-Duration Hard-Spectrum Bursts (ApJ

654:878)

► Foley, Perley, Pooley, Prochaska et al. 2006 - *GRB 050408: A Bright Gamma-Ray Burst Probing an Atypical Galactic Environment* (ApJ 645:450)

(3rd or 4th author: 22 papers, 685 citations)

- ► Cano, de Ugarte Postigo, **Perley** et al. 2015 *GRB 140606B/iPTF14bfu: detection of shock-breakout emission from a cosmological γ-ray burst?* (MNRAS 452:1535)
- ► Cenko, Urban, **Perley** et al. 2015 *iPTF14yb*: The First Discovery of a GRB Afterglow Independent of a High-Energy Trigger (ApJL 803:24)
- ► Singer, Kasliwal, Cenko, **Perley** et al. 2015 *The Needle in the 100 deg² Haystack:* Uncovering Afterglows of Fermi GRBs with the Palomar Transient Factory (ApJ 506:52)
- ► Horesh, Cenko, **Perley**, Kulkarni et al. 2015 *The unusual radio afterglow of the ultra-long gamma-ray burst GRB 130925A* (ApJ submitted)
- ► Laskar, Berger, Margutti, **Perley** et al. 2015 *Energy Injection in Gamma-ray Burst Afterglows* (ApJ submitted)
- ▶ Volnova, Pozanenko, Gorosabel, **Perley** et al. 2014 *GRB 051008: A long, spectrally-hard dust-obscured GRB in a Lyman-Break Galaxy at z* ~ 2.8 (MNRAS 442:2586)
- ► Grossan, Kumar, **Perley** et al. 2014 *A Small, Rapid Optical-IR Response Gamma-Ray Burst Space Observatory* (PASP 126:885)
- ► Singer, Cenko, Kasliwal, **Perley** et al. 2013 *Discovery and Redshift of an Optical Afterglow in 71 deg2: iPTF13bxl and GRB 130702A* (ApJL 776:34)
- ► Cucchiara, Prochaska, Perley, Cenko et al. 2013 Gemini Spectroscopy of the Short GRB 130603B Afterglow and Host (ApJ 777:94)
- ► Svensson, Levan, Tanvir, **Perley** et al. 2012 The dark GRB 080207 in an extremely red host and the implications for gamma-ray bursts in highly obscured environments (MNRAS 421:25)
- ► Guidorzi, Kobayashi, **Perley**, Vianello et al. 2011 *A faint optical flash in dust-obscured GRB 080603A: implications for GRB prompt emission mechanisms* (MNRAS 417:2124)
- ► Levan, Tanvir, Cenko, **Perley** et al. 2011 *An Extremely Luminous Panchromatic Outburst from the Nucleus of a Distant Galaxy* (Science 333:199)
- ► Cobb, Bloom, **Perley** et al. 2010 *Discovery of SN 2009nz Associated with GRB 091127* (ApJ 718:150)
- ► Cenko, Butler, Ofek, **Perley** et al. 2010 *Unveiling the Origin of GRB 090709A: Lack of Periodicity in a Reddened Cosmological Long-Duration Gamma-Ray Burst* (AJ 140:224)
- ► Pandey, Swenson, **Perley**, Gudorzi et al. 2010 *GRB 090902B: Afterglow Observations and Implications* (ApJ 714:799)
- ► Hurley, Rowlinson, Bellm, **Perley** et al. 2010 *A new analysis of the short-duration, hard-spectrum GRB 051103, a possible extragalactic soft gamma repeater giant flare* (MNRAS 403:342)
- ► Levesque, Bloom, Butler, **Perley** et al. 2010 *GRB090426*: the environment of a rest-frame 0.35-s gamma-ray burst at a redshift of 2.609 (MNRAS 401:963)
- ► Sheffer, Prochaska, Draine, **Perley** et al. 2009 *The Discovery of Vibrationally Excited H2 in the Molecular Cloud Near GRB 080607* (ApJL 701:63)
- ▶ Prochaska, Sheffer, **Perley**, Bloom et al. 2009 *The First Positive Detection of Molecular Gas in a GRB Host Galaxy* (ApJL 691:27)
- ► Miller, Chornock, **Perley**, Ganeshalingam et al. 2009 *The Exceptionally Luminous Type II-Linear Supernova 2008es* (ApJ 690:1303)
- ► Covino, D'Avanzo, Klotz, **Perley** et al. 2009 *The complex light curve of the afterglow of GRB071010A* (MNRAS 388:347)

▶ Butler, Li, **Perley**, Huang et al. 2006 - When Do Internal Shocks End and External Shocks Begin? Early-Time Broadband Modeling of GRB 051111 (ApJ 652:1390)

Select list of other notable papers (as >4th co-author):

- ► Gal-Yam et al. 2014 A Wolf-Rayet-like progenitor of SN 2013cu from spectral observations of a stellar wind (Nature 509:471)
- ► Cenko et al. 2013 Discovery of a Cosmological, Relativistic Outburst via its Rapidly Fading Optical Emission (ApJ 769:130)
- ▶ Bloom et al. 2011 A Possible Relativistic Jetted Outburst from a Massive Black Hole Fed by a Tidally Disrupted Star (Science 333:203)
- ► Tanvir et al. 2009 A Gamma-ray burst at a redshift of z~8.2 (Nature 461:1254)
- ► Modjaz et al. 2009 From Shock Breakout to Peak and Beyond: Extensive Panchromatic Observations of the Type Ib Supernova 2008D Associated with Swift X-ray Transient 080109 (ApJ 702:226)
- ► Fynbo et al. 2006 *No supernovae associated with two long-duration gamma-ray bursts* (Nature 444:1047)
- ▶ Bloom et al. 2005 Closing in on a Short-Hard Burst Progenitor: Constraints from Early-Time Optical Imaging and Spectroscopy of a Possible Host Galaxy of GRB 050509b (ApJ 638:354)