



Early Career Researchers At Work: Working In a Large Physics Collaboration

Amber L. Stuver

Caltech at the LIGO Livingston Observatory

and

The Louisiana State University

stuver@ligo-la.caltech.edu

My Background

- | M.Ed. physics (2001), Ph.D. physics (2006), from Penn State
- | Research:
 - » Primary: detection of gravitational waves (data analysis)
 - » Secondary: physics education
- | Dual appointment (non-tenure):
 - » Data Analysis & EPO Scientist at LIGO Livingston Observatory (Caltech)
 - » Instructor at the Louisiana State University
- | Primary research performed within a large collaboration
 - » 800+ authors (alphabetical)
 - » 60+ institutions within USA and worldwide

PHYSICAL REVIEW D 87, 022002 (2013)

Search for gravitational waves from binary black hole inspiral, merger, and ringdown in LIGO-Virgo data from 2009–2010

J. Aasi,¹ J. Abadie,¹ B. P. Abbott,¹ R. Abbott,¹ T. D. Abbott,² M. Abernathy,³ T. Accadia,⁴ F. Acernese,^{5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,147,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,175,176,177,178,179,180,181,182,183,184,185,186,187,188,189,190,191,192,193,194,195,196,197,198,199,200,201,202,203,204,205,206,207,208,209,210,211,212,213,214,215,216,217,218,219,220,221,222,223,224,225,226,227,228,229,230,231,232,233,234,235,236,237,238,239,240,241,242,243,244,245,246,247,248,249,250,251,252,253,254,255,256,257,258,259,260,261,262,263,264,265,266,267,268,269,270,271,272,273,274,275,276,277,278,279,280,281,282,283,284,285,286,287,288,289,290,291,292,293,294,295,296,297,298,299,300,301,302,303,304,305,306,307,308,309,310,311,312,313,314,315,316,317,318,319,320,321,322,323,324,325,326,327,328,329,330,331,332,333,334,335,336,337,338,339,340,341,342,343,344,345,346,347,348,349,350,351,352,353,354,355,356,357,358,359,360,361,362,363,364,365,366,367,368,369,370,371,372,373,374,375,376,377,378,379,380,381,382,383,384,385,386,387,388,389,390,391,392,393,394,395,396,397,398,399,400,401,402,403,404,405,406,407,408,409,410,411,412,413,414,415,416,417,418,419,420,421,422,423,424,425,426,427,428,429,430,431,432,433,434,435,436,437,438,439,440,441,442,443,444,445,446,447,448,449,450,451,452,453,454,455,456,457,458,459,460,461,462,463,464,465,466,467,468,469,470,471,472,473,474,475,476,477,478,479,480,481,482,483,484,485,486,487,488,489,490,491,492,493,494,495,496,497,498,499,500,501,502,503,504,505,506,507,508,509,510,511,512,513,514,515,516,517,518,519,520,521,522,523,524,525,526,527,528,529,530,531,532,533,534,535,536,537,538,539,540,541,542,543,544,545,546,547,548,549,550,551,552,553,554,555,556,557,558,559,560,561,562,563,564,565,566,567,568,569,570,571,572,573,574,575,576,577,578,579,580,581,582,583,584,585,586,587,588,589,590,591,592,593,594,595,596,597,598,599,600,601,602,603,604,605,606,607,608,609,610,611,612,613,614,615,616,617,618,619,620,621,622,623,624,625,626,627,628,629,630,631,632,633,634,635,636,637,638,639,640,641,642,643,644,645,646,647,648,649,650,651,652,653,654,655,656,657,658,659,660,661,662,663,664,665,666,667,668,669,670,671,672,673,674,675,676,677,678,679,680,681,682,683,684,685,686,687,688,689,690,691,692,693,694,695,696,697,698,699,700,701,702,703,704,705,706,707,708,709,710,711,712,713,714,715,716,717,718,719,720,721,722,723,724,725,726,727,728,729,730,731,732,733,734,735,736,737,738,739,740,741,742,743,744,745,746,747,748,749,750,751,752,753,754,755,756,757,758,759,760,761,762,763,764,765,766,767,768,769,770,771,772,773,774,775,776,777,778,779,780,781,782,783,784,785,786,787,788,789,790,791,792,793,794,795,796,797,798,799,800,801,802,803,804,805,806,807,808,809,810,811,812,813,814,815,816,817,818,819,820,821,822,823,824,825,826,827,828,829,830,831,832,833,834,835,836,837,838,839,840,841,842,843,844,845,846,847,848,849,850,851,852,853,854,855,856,857,858,859,860,861,862,863,864,865,866,867,868,869,870,871,872,873,874,875,876,877,878,879,880,881,882,883,884,885,886,887,888,889,890,891,892,893,894,895,896,897,898,899,900,901,902,903,904,905,906,907,908,909,910,911,912,913,914,915,916,917,918,919,920,921,922,923,924,925,926,927,928,929,930,931,932,933,934,935,936,937,938,939,940,941,942,943,944,945,946,947,948,949,950,951,952,953,954,955,956,957,958,959,960,961,962,963,964,965,966,967,968,969,970,971,972,973,974,975,976,977,978,979,980,981,982,983,984,985,986,987,988,989,990,991,992,993,994,995,996,997,998,999,1000}

J. AASI *et al.*

PHYSICAL REVIEW D 87, 022002 (2013)

D. L. Kinzel,¹ J. S. Kissel,²³ S. Klimek,¹⁵ J. Kline,¹³ K. Kokeyama,⁴⁶ V. Kondrashov,¹ S. Koranda,¹³ W. Z. Korth,¹ I. Kowalska,^{27b} D. Kozak,¹ V. Krings,^{9,10} B. Krishnan,¹⁹ A. Królak,^{27a,27c} G. Kuehn,^{9,10} P. Kumar,²² R. Kumar,³ R. Kurdyumov,²⁶ P. Kwee,²³ P. K. Lam,⁵⁴ M. Landry,¹⁷ A. Langley,⁶⁵ B. Lantz,²⁶ M. Lastzka,^{9,10} C. Lawrie,³ A. Lazzarini,¹ A. Le Roux,⁶ P. Leaci,¹⁹ C. H. Lee,⁵³ H. K. Lee,⁸¹ H. M. Lee,^{9,10} L. R. Leong,^{9,10} L. Leonor,⁴⁰ N. Leroy,^{21a} N. Lelandre,⁴ V. Lhuillier,¹⁷ J. Li,⁴⁶ T. G. F. Li,^{11a} P. E. Lindquist,¹ V. Livine,¹ Y. Liu,⁴⁶ Z. Liu,¹⁵ N. A. Lockerbie,⁸³ D. Lodhia,¹⁸ J. Logue,⁶ M. Lorenzini,^{39a} V. Loriette,^{31b} M. Lormand,⁶ G. Losurdo,^{30a} J. Lough,²² M. Lubinski,¹⁷ H. Lück,^{9,10} A. P. Lundgren,^{9,10} J. MacArthur,³ E. Macdonald,³ B. Machenschalk,^{9,10} M. MacInnis,²³ D. M. Macleod,⁷ M. Mageswaran,¹ K. Mailand,¹ E. Majorana,^{16a} I. Maksimovic,^{31b} V. Malvezzi,^{57a} N. Man,^{35a} I. Mandel,¹⁸ V. Mandic,⁶¹ M. Mantovani,^{14a} F. Marchesoni,^{38a,38c} F. Marion,⁴ S. Márka,²⁵ Z. Márka,²⁵ A. Markosyan,²⁶ E. Maroc,¹ J. Marquet,²¹ F. Martelli,^{30a,30b} I. W. Martin,³ R. M. Martin,¹⁵ J. N. Marx,¹ K. Mason,²³ A. Masserot,⁴ F. Matichard,²³ L. Matone,²⁵ R. A. Matzner,⁸⁴ N. Mavalvala,²³ G. Mazzolo,^{9,10} R. McCarthy,¹⁷ D. E. McClelland,⁵⁴ S. C. McGuire,¹⁵ G. McIntyre,¹ J. McIver,⁴⁴ G. D. Meadors,⁴⁷ M. Mehmet,^{9,10} T. Meier,^{10,9} A. Melatos,⁵⁶ A. C. Melissinos,⁶⁶ G. Mendell,¹⁷ D. F. Menéndez,³⁴ R. A. Mercer,¹³ S. Meshkov,³ C. Messenger,⁷ M. S. Meyer,⁶ H. Miao,⁵¹ C. Michel,³⁶ L. Milano,^{5a,5b} J. Miller,²⁴ Y. Minenko,^{57a} C. M. F. Mingarelli,¹⁸ V. P. Mirosfanov,³⁰ G. Mitselmakher,¹⁵ R. Mittelman,²³ B. Moe,¹³ M. Mohan,²¹ S. R. P. Mohapatra,⁴² D. Moraru,¹⁷ G. Moreno,¹⁷ N. Morgado,³⁶ A. Morgin,^{57a,57b} T. Mott,¹² S. R. Morris,²⁸ S. Mosca,^{5,6,5b} K. Mossavi,^{9,10} B. Mourz,⁴ C. M. Mow-Lowry,⁵⁴ C. L. Mueller,¹⁵ G. Mueller,¹⁵ S. Mukherjee,²⁸ A. Mullahavey,^{48,54} H. Müller-Ebhardt,^{9,10} J. Munch,⁸⁷ D. Murphy,²⁵ P. G. Murray,³ A. Mytidis,¹⁵ T. Nash,¹ L. Naticchioni,^{16a,16b} V. Nuccia,¹⁵ J. Nelson,³ L. Neri,^{38a,38b} G. Newton,³ T. Nguyen,⁵⁴ A. Nishizawa,¹² A. Nitz,²² F. Nocera,²¹ D. Nolting,⁶ M. E. Normandin,²⁸ L. Nuttall,⁷ E. Ochsner,¹³ J. O'Dell,¹⁷ E. Oelker,²³ G. H. Ogin,¹ J. J. Oh,⁸⁸ S. H. Oh,⁸⁸ R. G. Oldenhard,¹³ B. O'Reilly,⁸ R. O'Shaughnessy,¹³ C. Osheter,¹ C. D. Ott,⁵¹ D. J. Ottaway,⁴⁷ R. S. Ottens,¹⁵ H. Overmier,⁶ B. J. Owen,¹⁴ A. Page,¹⁸ L. Palladino,^{57a,57c} C. Palomba,^{16a} Y. Pan,² C. Pankow,¹³ F. Paoleto,^{14a,21} R. Paoleto,^{14a,21} M. A. Papa,^{10,13} M. Parisi,^{5a,5b} A. Pasqualetti,²¹ R. Passaquies,^{14a,21} D. Passuello,^{14a} M. Pedraza,³ S. Penn,⁷ A. Perreca,²⁷ G. Persichetti,^{3a,5b} M. Phelps,¹ M. Pichot,^{35a} M. Pickenpack,^{9,10} E. Piergiovanni,^{39a,39b} V. Pierro,^{34a} M. Pihlaja,⁶³ L. Pinard,³⁷ I. M. Pinto,⁵⁴ S. M. Piskun,^{11b} J. H. Pletsch,^{9,10} M. V. Plessi,¹ R. Poggiani,^{9,10} J. Pöhl,^{9,10} F. Postiglione,³⁸ C. Poux,¹ M. Prato,⁵² V. Predki,⁷ T. Prestegard,¹⁰ L. R. Price,¹ M. Prijatelj,^{9,10} M. Principe,^{5a,8} S. Privitera,¹ R. Prix,^{9,10} G. A. Prodi,^{64a,64b} L. G. Prokhorov,³⁰ O. Puntken,^{9,10} M. Punturo,^{38a} P. Puppato,^{16a} V. Quetschke,²⁸ R. Quitzow-James,⁴⁰ F. J. Raab,¹⁷ D. S. Rabeling,^{11a,11b} I. Rácz,⁶¹ H. Radkins,¹⁷ P. Raffai,^{25,68} M. Rakhmanov,²⁸ C. Ramet,⁶ B. Rankins,⁴⁹ P. Rapagnani,^{16a,16b} V. Raymond,⁶⁶ V. Re,^{57a,57b} C. M. Reed,¹⁷ T. Reed,¹⁷ T. Regimbau,^{35a} S. Reid,³ D. H. Reitze,³ F. Ricci,^{16a,16b} R. Riesen,⁶ K. Riles,⁴⁷ M. Roberts,²⁶ N. A. Robertson,¹³ F. Robinet,^{38a} C. Robinson,⁷ E. L. Robinson,¹⁹ A. Rocchi,^{37a} S. Roddy,⁶ C. Rodriguez,⁶⁶ M. Rodruck,¹⁷ L. Roland,⁴ J. G. Rollins,¹ R. Romano,^{5a,5b} J. H. Romie,⁶ D. Rosinica,^{27c} C. Röver,^{9,10} S. Rowan,³ A. Rüdiger,^{9,10} P. Ruggi,²¹ K. Ryan,¹⁷ F. Salemi,^{9,10} I. Sammut,⁵⁶ V. Sandberg,¹⁷ S. Sankar,²³ V. Sanmihale,¹ L. Santamaría,¹ I. Santiago-Prieto,³ G. Santostasi,⁹⁰ E. Saracco,³⁶ B. Sassolas,³⁶ B. S. Sathyaprakash,⁷ P. R. Saulson,²² R. L. Savage,¹⁷ R. Schilling,^{9,10} R. Schnabel,^{9,10} R. M. S. Schofield,¹⁰ B. Schutz,^{9,10} B. F. Schutz,^{10,7} P. Schwinberg,¹⁷ J. Scott,³ S. M. Scott,⁵⁴ F. Seifert,¹ D. Sellers,⁶ D. Sentenac,²¹ A. Sergeev,⁷⁹ D. A. Shaddock,⁵⁴ M. Shallev,^{9,10} B. Shapiro,²³ P. Shawhan,⁴² D. H. Shoemaker,²³ T. L. Sidery,¹⁸ X. Siemens,¹³ D. Sigg,¹⁷ D. Simakov,^{9,10} A. Singer,¹ L. Singer,¹ A. M. Sintes,⁴³ G. R. Skelton,¹³ B. J. J. Slagmolen,³⁴ J. Slutsky,⁴⁸ J. R. Smith,⁷ M. R. Smith,⁷ R. E. J. E. Smith,¹⁷ N. D. Smith-Lefebvre,²³ G. K. Somiya,⁵¹ B. Sorazu,⁵⁷ F. C. Speirits,¹³ L. Sperandio,^{57a,57b} M. Stefczyk,⁵⁴ E. Steinert,¹⁷ J. Steinlechner,^{9,10} S. Steinlechner,^{9,10} S. Steplowski,¹⁷ A. Stochino,¹ R. Stone,²⁸ K. A. Strain,³ S. E. Strigin,³⁰ A. S. Stroeter,²⁸ R. Strunz,^{39a,39b} A. L. Stuver,⁶ C. Z. Summerscales,⁹¹ M. Sung,⁴⁸ S. Susmithan,³³ P. J. Sutton,⁷ B. Swinkels,²¹ G. Szeifert,⁶⁸ M. Tacca,¹ L. Taffarello,^{64c} D. Talukder,³⁷ D. B. Tarnes,¹⁵ S. P. Tarabrin,^{9,10} R. Taylor,¹ A. A. M. ter Braack,^{11a} P. Thomas,¹⁷ K. A. Thorne,⁶ K. S. Thorne,⁵¹ E. Thrane,⁶³ A. Thuring,^{10,9} C. Thüsler,³⁴ K. V. Tokmakov,⁶³ C. Tomlinson,⁶⁰ A. Tonelli,^{14a,21} M. Tonelli,¹⁰ G. Torre,^{14a,21} C. J. Torres,²⁸ C. L. Torrie,¹⁵ E. Tournefier,⁴ F. Travasso,^{38a,38b} G. Traylor,⁶ M. Tse,²⁵ D. Ugolini,⁹² H. Vahlbrach,^{10,9} G. Vajente,^{14a,14b} J. F. J. van den Brand,^{11a,11b} C. Van Den Broeck,^{11a} S. van der Putten,^{11a} A. A. van Veggel,³ S. Vass,¹ M. Vasuthi,⁶¹ R. Vaulin,²⁰ M. Vavoulidis,^{61a} A. Vecchio,¹⁸ G. Vedovato,⁶⁶ J. Veitch,⁷ P. J. Veitch,⁸ K. Venkateswara,⁶³ D. Verkindt,⁴ F. Vetranò,^{39a,39b} A. Vicere,^{39a,39b} A. E. Villar,¹ J.-Y. Vinet,^{35a} S. Vitale,^{11a} H. Vocca,^{38a} C. Vorvick,¹⁷ S. P. Vyatchanin,³⁰ A. Wade,⁵⁴ L. Wade,¹³ M. Wade,¹³ A. J. Waldman,²³ L. Wallace,⁹ Y. Wan,⁴⁶ M. Wang,¹⁸ X. Wang,⁴⁶ A. Warner,^{9,10} R. L. Ward,²¹ R. M. Was,^{31a} M. Weinstein,^{9,10} A. J. Weinstein,¹ R. Weiss,²³ T. Welborn,⁶ L. Wen,^{5,13} P. Wessels,^{9,10} M. West,²² T. Westphal,^{9,10} K. Wette,^{9,10} J. T. Whelan,⁶⁷ S. E. Whitcomb,¹³³ D. J. White,⁶⁰ B. F. Whiting,¹⁵ K. Wiesner,^{9,10} C. Wilkinson,¹⁷ P. A. Willems,¹ L. Williams,¹⁵ R. Williams,¹⁵ B. Willke,^{9,10} M. Wimmer,^{9,10} L. Winkelmann,^{9,10}

Current Research Process

- | Publishing results using current data necessitates a full author list.
 - » Full author list papers usually take months from the beginning of composition to submission to journal.
 - » Only papers on new methodology (analysis algorithms, calibration, etc.) publish with short author lists.

- | Full author list publication process:
 - » In general, use recent data collected with the LIGO detectors and other international detector(s) if concurrently operational.
 - » Specialized search groups apply different techniques and methodologies to search for gravitational waves in noisy data.
 - » Results papers written by groups; sections written by individuals
 - » Drafts are revised several times by the group.
 - » Mature draft sent to publications committee which performs internal peer review and opens paper to comments from the collaboration.

Group Paper Writing

- | Many references for results papers have been established.
 - » >70 results papers have been published by the collaboration.

- | New references are always added. Examples:
 - » New astrophysical population estimates
 - » New techniques in signal processing
 - » New instrumental techniques

- | Write papers and share references using revision control systems (CVS/SVN/Git)
 - » Most of my collaborators are also software developers – we write our papers and share references within the same infrastructure we develop software.

How I Do My Literature Searches

- | When performing a literature review, I usually want to know more about how an idea I've had has been explored (or not) in the past:
 - » Find a recent relevant article.
 - » Check “Refers to” listings.
 - » Repeat until originating article found.
 - » Check “Cited by” listings for originating article.
 - » Repeat looking for articles duplicating research I'd like to do.

- | Services I frequent:
 - » Arxiv (this is where I *always* start)
 - » NASA ADS
 - » INSPIRE

Journal Peer Review

- | After the rigors of developing a publication in the LIGO Scientific Collaboration, I feel very well prepared for the peer review process.
 - » Once full author list papers make it to this stage, it is rare to be rejected.
 - » Short author list papers are also subjected to collaboration review.
 - » Collaboration will also comment on paper's appropriateness for a target journal.
- | This is often where concerns that are not obvious to non-experts in the field come to light.
- | Realistically, the system seems to work well.
 - » Things like turn-around time will always be something we wish could be faster (that is, as a publishing author and not a referee).

Academic Profiling & Networking

| ResearchGate

- » Actively promotes posting full text of journal articles (can see requests for full texts of publications as well)

| Academia.edu

| The social networking aspects of these are interesting but not important to me.

- » ResearchGate gives you a score reflecting your “reputation” calculated from your activity on the service.
- » Academia.edu relies more on statistics of profile & article views.

| INSPIRE-HEPNAMES

- » The ability to associate the variations on my name as belonging to me (as a single person) increases my visibility and impact.
- » I am also listed in the ORCID as 0000-0003-0324-5735.

Access To Publications

- | Before my dual appointment, I was over 1,800 miles away from the Caltech's physical library.
 - » If the resource isn't accessible online, it's useless to me.
 - » Electronic archiving of old volumes has been very valuable and markedly better from my days in grad school (1999-2006).
- | Caltech doesn't always have access to education journals that I use to look for references (e.g. *The Physics Teacher* [AAPT]).
 - » I get around this by having access through society membership and affiliation with another institution.
- | Open access publishing model
 - » arXiv makes many publications "open access".
 - » Tenure track peers are concerned about the cost of open access publishing.
 - » Potential to flood the internet with bogus journals (public disservice)

Suggestions

- | Anything that increases access to papers, while maintaining integrity, is more than welcome.
 - » This may be even more strongly felt by industrial physicists.
 - » E.g. open access, refers to/cited by cross linking

- | Promote the Open Researcher and Contributor Identification (ORCID) system to increase our impact.
 - » That way A. Stuver, A. L. Stuver, and Amber Stuver are all recognized as me.

- | Ensure transparency in the reviewing process to preserve trust.
 - » Bogus journals and conferences that collect “open access” fees and publish anything threaten the trust of researchers.

References

- | LIGO Scientific Collaboration Publication Policy:
 - » <https://dcc.ligo.org/LIGO-T010168-v6/public>

- | LIGO Scientific Collaboration Review Policy:
 - » <https://dcc.ligo.org/LIGO-M060334-v4/public>