Department of Physics and Astronomy
Oberlin College

Report for the Academic Year 2007-2008

Introduction

The Department of Physics and Astronomy, while flourishing, had a relatively quiet year. We have no EPPC Program Review to report, nor any staff hiring. We were delighted to welcome Jason Stalnaker in the first year of his tenure-track appointment, as an addition to our department provided by the gift of John and Marianne Schiffer. A significant amount of time at staff meetings was occupied by planning for new curricular initiatives, and talking about opportunities presented by the replacement of the retiring department chair.

1. Staffing and Personnel

During the 2007-08 academic year, the department had an authorized faculty size of 7.5 FTE, including 1 FTE of built-in leave replacement (BIR). The members of our faculty are

Stephen FitzGerald, *Associate Professor* (0.75 FTE)
Yumi Ijiri, *Associate Professor* (0.75 FTE)
Chris Martin, *Assistant Professor*
Bruce Richards, *Professor and Chair*
John Scofield, *Professor*
Jason Stalnaker, *Assistant Professor*
Dan Stinebring, *Federighi Professor*
Dan Styer, *Schiffer Professor*

Chris Martin was awarded a mid-probationary leave for the entire year, which he spent as a visiting researcher at the Steward Observatory of the University of Arizona. John Scofield took a year-long sabbatical leave, working on the research staff of a blue-ribbon committee appointed by the American Physical Society to study energy efficiency in buildings and transportation. Even though two of our faculty were on leave, we were able to present our traditional department curriculum without requiring the services of any adjunct or temporary leave replacement faculty. We could do this as a result of our BIR and by using, this year only, Jason Stalnaker's new position as a leave replacement. Next year his addition to our faculty will enable our department to offer some long-needed new courses.

In addition to the above, Melinda Keller, *Instructor in Physics and Laboratory Manager*, ably taught the laboratory sections in Physics 103 and the lectures in Physics 104, while serving as our web master and managing our facilities.

The Department's work was also supported by Diane Doman, our full-time administrative assistant, Aaron Clark, our full-time laboratory technician, and Elaine McQuate, our continuing part-time clerical assistant. In addition, planetarium and observatory operations received part-time support from Mike Williams. His work, in conjunction with Dan Stinebring, has resulted in very effective community outreach programs in astronomy. Two additional persons supporting our program and supervised by the Chair of the Physics and Astronomy Department are Bill Mohler, the science division's invaluable electronics specialist, and Bill Marton, part-time machinist/scientific apparatus maker, both of whom work in the Wright Laboratory of Physics.

This academic year was the last year of teaching for Professor Bruce Richards before his retirement. His fall career sabbatical and absence during the remainder of the year will be covered by the department's BIR. Early in the fall of 2008 the department will submit a request for the return of his position and it hopes to conduct a search for his replacement during the 2009-2010 academic year.

2. Students and Alumni

Nine students graduated with physics majors in the spring of 2008. This number is very close to our average of around 10.5 students over the last 10 years. Four had concentrations in astrophysics. Three of this year's graduates will enter graduate school this fall, while three more have plans for graduate work at a later time. Jobs lined up include work as an analytical chemist, work as a sound engineer, work with children in urban agriculture, and directing the America Counts Program in the Oberlin Public Schools. Two are still searching for jobs.

Two students received honors at graduation. Their names, project titles, and mentors were:

Courtney Epstein	*Through a Glass Darkly: Pulsar Imaging by the Intersteller Medium*	Dan Stinebring
Patrick Landreman	*An Acoustical Evaluation of the QRD Diffractal™ in Finney Chapel*	Bruce Richards

During this year, the Oberlin College Library joined a project to store electronic copies of student honors papers in an OhioLINK archive. The first six theses from Oberlin to be placed there are from recent physics graduates. These six papers now have a permanent archival URL, and this year's two reports will soon be added to the collection.

Our Department strives to provide independent research experience to as many majors as possible, not just honors students. In many cases, summer research assistantships supported by Oberlin faculty research grants provide these opportunities. During the summer of 2007 five undergraduates, one of them a student at Swarthmore, worked in the department; during the summer of 2008 the number was eight. In other cases, our students find summer research positions at major universities under the auspices of the National Science Foundation's Research Experience for Undergraduates program. Other occasions are provided during academic semesters and winter terms. Surveys show that virtually all of our majors have participated in

research before they graduate. A table in Appendix II lists 19 students who had research projects not associated with regular academic classes in our department in 2007-08, along with abbreviated names of their mentors. The two honors students are indicated by (H).

Two of our alumni participated in work that was recognized by a Nobel prize this year. The 2007 Nobel Peace Prize was shared equally between Al Gore and the UN Intergovernmental Panel on Climate Change. In the 2007 IPCC Fourth Assessment Report from their Working Group I on the Physical Science Basis, one of the lead authors for Chapter 5, ("Observations: Oceanic Climate Change and Sea Level,") was Lynne Talley, OC '76, double degree in piano performance and physics, now Professor of Oceanography at Scripps Institute of Oceanography in San Diego. Not on the list of authors at the same level, but also involved in the work of the IPCC, was Stephen Klein, an OC '89 physics major.

In addition, one of Oberlin's honorary degree recipients this year is Stuart Card, OC '66, who majored in physics and later engaged in a study of human-computer interactions that culminated in the invention of the ubiquitous computer mouse.

3. Courses Enrollments

The Registrar's lists of courses offered by our Department in 2007-08 are given in Appendix I. Specific comments have been requested on courses that enrolled more than 50 or fewer than 6 students.

The Department of Physics and Astronomy has traditionally offered several large-enrollment lecture courses for students who aren't majoring in science, to expose a large number of Oberlin students to the wonders of physics and to facilitate their meeting the natural science piece of the 9-9-9 requirement. These courses prove to be very popular, and their enrollments are usually limited primarily by the seating capacity of the rooms in which they are taught. In this category during 2007-08 were ASTR-100 *Introductory Astronomy* (enrollment 113), PHYS-054 *Musical Acoustics* (enrollment 74), PHYS-051 *Einstein and Relativity* (enrollment 170), and PHYS-052 *Strange World of Quantum Mechanics* (enrollment 152).

The trend in science teaching today is toward learning by discovery and active participation on the part of students, but that is very difficult to do in a class with 70+ students and a single instructor, and without associated multiple laboratory sections. Teaching science well to a general audience would be much easier if the enrollments were limited to no more than 20 or so. Indeed, the First Year Seminar Program has requested that our Department develop and offer one or more courses with enrollments limited to 14 entering students. However, exchanging one of our large-enrollment courses for one so small would result in a significant reduction in the number of seats available to students needing to satisfy their natural science requirement.

One technical aid we used for the second year in 2007-08 to maximize student involvement and participation in several large-enrollment courses is a classroom response system, in which each student has a remote device ("iClicker") containing five buttons enabling him or her to respond to multiple-choice questions posed by the instructor at several points during the lecture. The

instructor's computer collects the responses and displays a summary of the results *via* a data projector. Students enjoyed this way of checking their understanding of class material and generating discussion when understanding was incomplete. Courses in which iClickers were used this year include ASTR-100, PHYS-054, PHYS-103, PHYS-104, and PHYS-110.

The only regular lecture course with an enrollment of less than 6 students was PHYS-410 *Thermodynamics and Statistical Mechanics* (enrollment 5). This course is offered for seniors expecting to go to graduate school, and hence is both essential for some majors and not of interest to others. It is not required for the major. The enrollment in PHYS-410 is usually 5 or greater.

4. Curriculum Development

The addition of a faculty position to our department due to the Schiffer gift has resulted in a year of concentrated curricular discussions. In conjunction with making plans to add several new courses, we have proposed several changes to the requirements of our major with the goal of making it more flexible. All of the changes have been approved by the EPPC and appear in the 2008-09 course catalog, where full information may be found. I will first describe the new courses to be introduced next year, and then summarize the changes to our major requirements.

Two new courses will be introduced in response to requests from students, as well as comments from our recent outside program reviewers and our own assessment of the needs of our program. The first is an intermediate course on Waves and Optics (PHYS-316). This is a course offered by all first-rate physics departments and eliminates a long-recognized gap in our curriculum. It is a natural course to be taught by new department member Jason Stalnaker, since his research relies heavily on techniques of modern optics.

The second new course is on Computational Physics (PHYS-290). As the power of computers has increased to levels almost unimaginable several years ago, computational physics has joined theoretical and experimental physics as the third major way to explore physics phenomena, and any forward-looking physics department should be providing students with training in data analysis, simulation, visualization, and modeling using a computer. We are fortunate that several members of our department have interests and skills in this area, as indicated by their prominent roles in the Oberlin Center for Computation and Modeling (OCCaM). Chris Martin will teach this new course.

Directors of the First Year Seminar Program (FYSP) have repeatedly asked the Department of Physics and Astronomy to offer a small-enrollment course for entering students. With our limited resources, we have traditionally felt that we could most efficiently serve the needs of students not majoring in science through our large, general audience courses. However, next year Yumi Ijiri will offer The Nature of Electronic Materials: Deconstructing the Computer (FYSP-143), the department's first FYSP course.

Given the intense interest of many Oberlin students in environmental problems, the department has become convinced that we could make a significant and unique contribution to campus

discussions and student careers in this area by offering a course on the physics of environmental issues. Based on his long-standing interests in this area plus the knowledge he has gained from this year's sabbatical activities, John Scofield has agreed to offer the new course Environmental Physics (PHYS-268) next year.

Many departments of physics offer a full year's course in electricity and magnetism as well as a full year of quantum mechanics. In both cases, the second semester with more advanced material is important to students hoping to pursue undelayed full-time graduate study in physics. In our case, we have had in our curriculum the semester courses PHYS-311 and PHYS-411 for electricity and magnetism, and PHYS-312 and PHYS-412 for quantum mechanics. However, for several years due to staff limitations and low enrollments we have not been able to offer PHYS-411; during 2007-08 we could not offer PHYS-412. We would like to return these 400-level courses to our curriculum. On close analysis this year, we decided that we could include the most essential parts of these courses in half-semester modules. Then graduate-school bound majors could get the more advanced work they need in both areas in one semester instead of two, while others with particular interests in one or the other area could satisfy their interests in a module. Therefore, we have resurrected PHYS-411 and PHYS-412 as half-semester modules, which will be taught next year by Dan Styer.

Along with planning to introduce these new courses next year, we have made two main changes to the requirements for our major. The first change is to introduce a new concentration within the major, in materials physics. This new concentration will provide a third route through the major, which now has an astrophysics concentration and a traditional physics concentration. Unlike the present concentration in physics, the new concentration in materials physics would:

a) require introductory chemistry (with lab) rather than PHYS-414 (Advanced Laboratory),
b) permit either the physics or chemistry version of quantum mechanics (PHYS-312 or CHEM-339),
c) require that PHYS-340 (formerly Solid State Physics and now Physics of Materials) be one of the intermediate physics courses chosen to satisfy the major.

Our main reason for adding a third route to the major is that a significant number of our students go on to graduate work in materials physics, either in an applied physics or materials science department or still within a physics graduate program. This trend is consistent with the field as a whole; the division of condensed matter physics is the largest subgroup in the American Physical Society, and the *Physical Review B: Condensed Matter and Materials Physics* contains the most articles in the *Physical Review* series (A-E). While the current physics major provides good preparation, it would be better to signal the importance of chemistry and highlight further an existing elective course in solid state physics. As noted above, this course will be recast as a course in materials physics, with more emphasis on technologically important materials (as is more commonly presented in an engineering course).

In addition, this third route would bring additional flexibility to our major, particularly for students who initially intend a 3-2 engineering major but wish to switch to a physics major. It would allow them some flexibility in upper level lab requirements, and take advantage of their most likely having already taken introductory chemistry courses. The new concentration might

also attract a few students initially starting a chemistry major who later find physics more attractive.

The second change in our major is also designed to make the requirements for the traditional physics concentration more flexible, by providing more choices at the upper level. This is facilitated by some of the new courses being offered next year. Formerly, for the required upper-level theory courses physics majors could choose three 300- and 400-level semester courses from a list of six. In actual fact, because of prerequisites, for most students the three courses were PHYS-310, PHYS-311, and PHYS-312. In over-simplified terms, the new requirement is for two courses from a list of five, while the third course can come from a much broader list that includes eight courses (the two lists have some overlap). This change will allow a student to tailor his or her program better to meet specific interests; physics majors will no longer all be taking exactly the same courses.

In this discussion of courses offered by the Department of Physics & Astronomy, it should be pointed out regretfully that with the retirement of Bruce Richards the general-audience course in Musical Acoustics (PHYS 054) will no longer be offered. It should also be emphasized that there is no way to sustain the above curricular initiatives without the return of his position to the Physics & Astronomy Department.

5. Visiting Speakers Program

The Department of Physics & Astronomy has a very successful visiting speakers program, which introduces our majors to current areas of research in physics, or topics not covered in our courses, or representatives of non-academic but physics-related careers. Two annual lectures sponsored by special funds are the Hays lecture and the Anderson lecture, both designed for a general college-wide audience. All of these visitors enrich the life of our department.

The number of speakers varies from year to year, depending on schedules and the availability of those we invite. During 2007-08 we heard 13 talks. These included presentations by our two honors students, two speakers we co-sponsored with OCCaM, and one we co-sponsored with the Mathematics Department. Two of these speakers came through an exchange program with physics departments of the Ohio 5 group of colleges, in a program that was organized and run by our faculty. The Anderson Lecturer was Martin Harwit of Cornell University (OC ’51); the Hays Lecturer was Robert Greenler of the University of Wisconsin – Milwaukee. A complete list of speakers, dates, and topics may be found on our departmental web site at URL http://www.oberlin.edu/physics/news/speakers.html.

6. Strategic Indicators

Listed in Appendix III are seven research grants held by faculty in the Department of Physics & Astronomy, and 17 publications appearing in refereed journals during 2007-08 with names of student co-authors underlined. Of the research grants, two are from the National Science

Foundation and two are from the National Aeronautics and Space Administration. This is a remarkable record for a department in a 4-year liberal arts college.

7. Assessment

A discussion of assessment activities in the Department of Physics & Astronomy is given in a separate section accompanying this report.

Bruce Richards, Chair
Department of Physics & Astronomy
June 23, 2008

Appendix I

Fall 2007

CRN	Section	Title	EnrLim	Enrollment	% Full
1023	ASTR-100-01	Introductory Astronomy	120	113	94
7347	PHYS-054-01	Musical Acoustics	75	74	98
7560	PHYS-058-01	Charm & Strange Elem Particles	24	20	83
1464	PHYS-103-01	Elementary Physics I	60	45	75
1465	PHYS-103-02	Elementary Physics I	20	10	50
1466	PHYS-103-03	Elementary Physics I	20	16	80
1467	PHYS-103-04	Elementary Physics I	20	19	95
1468	PHYS-110-01	Mechanics and Relativity	60	48	80
4803	PHYS-110-02	Mechanics and Relativity	20	17	85
4804	PHYS-110-03	Mechanics and Relativity	20	15	75
4805	PHYS-110-04	Mechanics and Relativity	20	16	80
5893	PHYS-212-01	Modern Physics	32	17	53
5895	PHYS-212-02	Modern Physics	16	5	31
7348	PHYS-212-03	Modern Physics	16	12	75
1476	PHYS-312-01	Quantum Mechanics	20	14	70
1477	PHYS-314-01	Intermediate Laboratory	15	13	86
3762	PHYS-410-01	Statistical Mechanics	20	5	25
1478	PHYS-451-01	Spec Probs in Physics & Astron	5	0	0
1479	PHYS-451-02	Spec Probs in Physics & Astron	5	0	0
1480	PHYS-451-03	Spec Probs in Physics & Astron	5	0	0
1481	PHYS-451-04	Spec Probs in Physics & Astron	5	2	40
4294	PHYS-451-05	Spec Probs in Physics & Astron	5	0	0
4297	PHYS-451-06	Spec Probs in Physics & Astron	5	1	20
4628	PHYS-451-07	Spec Probs in Physics & Astron	5	0	0
5897	PHYS-451-08	Spec Probs in Physics & Astron	5	0	0
7350	PHYS-451-09	Spec Probs in Physics & Astron	5	0	0
1492	PHYS-555-01	Research	5	1	20
1493	PHYS-555-02	Research	5	0	0
1494	PHYS-555-03	Research	5	0	0
1495	PHYS-555-04	Research	5	1	20
4295	PHYS-555-05	Research	5	0	0
4298	PHYS-555-06	Research	5	0	0
4630	PHYS-555-07	Research	5	0	0
5898	PHYS-555-08	Research	5	0	0
7351	PHYS-555-09	Research	5	0	0
1498	PHYS-995-01	Private Reading	5	0	0
1499	PHYS-995-02	Private Reading	5	0	0
1500	PHYS-995-03	Private Reading	5	0	0
3422	PHYS-995-04	Private Reading	5	0	0
4296	PHYS-995-05	Private Reading	5	0	0
4299	PHYS-995-06	Private Reading	5	0	0
4631	PHYS-995-07	Private Reading	5	0	0
5899	PHYS-995-08	Private Reading	5	0	0
7352	PHYS-995-09	Private Reading	5	0	0

Spring 2008

CRN	Section	Title	EnrLim	Enrollment	% Full
13990	ASTR-117-01	Meteorite Impacts Space & Time	70	18	25
13989	GEOL-117-01	Meteorite Impacts Space & Time	70	40	57
14067	ASTR-302-01	Astrophysics II	20	9	45
14068	PHYS-051-01	Einstein and Relativity	230	170	73
14069	PHYS-052-01	Strange World Quantum Mechanic	230	152	66
7351	PHYS-104-01	Elementary Physics II	60	35	58
7352	PHYS-104-02	Elementary Physics II	20	6	30
7353	PHYS-104-03	Elementary Physics II	20	13	65
10505	PHYS-104-04	Elementary Physics II	20	16	80
7355	PHYS-111-01	Elect/Magnetism/Thermo	60	42	70
7356	PHYS-111-02	Elect/Magnetism/Thermo	20	13	65
7357	PHYS-111-03	Elect/Magnetism/Thermo	20	17	85
7358	PHYS-111-04	Elect/Magnetism/Thermo	20	12	60
14193	PHYS-151-01	Climate Modeling	16	14	87
7363	PHYS-310-01	Classical Mechanics	20	16	80
7364	PHYS-311-01	Electricity and Magnetism	20	10	50
14070	PHYS-340-01	Solid State Physics	20	7	35
7366	PHYS-414-01	Advanced Laboratory	14	7	50
8238	PHYS-451-01	Spec Probs in Physics & Astron	5	1	20
8239	PHYS-451-02	Spec Probs in Physics & Astron	5	0	0
8240	PHYS-451-03	Spec Probs in Physics & Astron	5	0	0
9459	PHYS-451-04	Spec Probs in Physics & Astron	5	1	20
8241	PHYS-451-05	Spec Probs in Physics & Astron	5	1	20
8242	PHYS-451-06	Spec Probs in Physics & Astron	5	2	40
8243	PHYS-451-07	Spec Probs in Physics & Astron	5	0	0
12575	PHYS-451-08	Spec Probs in Physics & Astron	5	0	0
14071	PHYS-451-09	Spec Probs in Physics & Astron	5	0	0
8252	PHYS-555-01	Research	5	1	20
8253	PHYS-555-02	Research	5	0	0
8254	PHYS-555-03	Research	5	0	0
9461	PHYS-555-04	Research	5	1	20
8255	PHYS-555-05	Research	5	0	0
8256	PHYS-555-06	Research	5	0	0
8257	PHYS-555-07	Research	5	0	0
12576	PHYS-555-08	Research	5	0	0
14072	PHYS-555-09	Research	5	0	0
8259	PHYS-995-01	Private Reading	5	0	0
8260	PHYS-995-02	Private Reading	5	0	0
8261	PHYS-995-03	Private Reading	5	0	0
9462	PHYS-995-04	Private Reading	5	1	20
8262	PHYS-995-05	Private Reading	5	0	0
8263	PHYS-995-06	Private Reading	5	0	0
8264	PHYS-995-07	Private Reading	5	0	0
12577	PHYS-995-08	Private Reading	5	0	0
14073	PHYS-995-09	Private Reading	5	0	0

Appendix II

Students having research projects in 2007-08 and their mentors

Student	Sum 07	Fall 07	WT 08	Spr 08	Sum 08
Bernfeld, Sean				STAL	STAL
Breslauer, Ben	IJIR	STIN		STIN	
Brooks, Rachel			IJIR		
Burkholder, Brian		FITZ		FITZ	FITZ
Conlon, Catherine				IJIR	IJIR
Epstein, Courtney (H)		STIN	STIN	STIN	
Harris, Sydney					STIN
Hershkowitz, Cole		IJIR			
Hopkins, Jesse	FITZ	FITZ		FITZ	
Landreman, Patrick (H)		RICH	RICH	RICH	
Lesser, David					MART
Matters, John	FITZ				
Miller, Rossina		STIN		STIN	
Myers, Ross	FITZ				
Quinlan, Alex		IJIR	IJIR		
Schlawin, Everett		STIN		STIN	
Spencer, Keith					STIN
Zelaski, Alexandra	IJIR				IJIR
Zhang, Peter					FITZ

Appendix III

Research Grants and Publications, 2007-08

Research Grants

S. A. FitzGerald, Petroleum Research Fund, "*Investigating the Quantum Dynamics of Trapped Hydrogen Using Infrared Spectroscopy*," $55,000 (2007-).

Y. Ijiri, NSF-RUI grant "*Magnetic interactions in nanoparticle systems*," $126,120 (2007-).

Y. Ijiri, Research Corporation Cottrell College Science Award, "*Magnetic finite size effects in iron-based nanoparticles*," $62,410 (2003-).

C. Martin, NASA grant "*The Stratospheric Terahertz Observatory*," $97,000 (2008-2011).

C. Martin, European Space Agency and NASA, "*The Herschel Inner Galaxy Gas Survey*," $360,000 (2008-2011).

D. Stinebring, NSF-RUI grant "*Pulsar scintillation – probing the interstellar medium and improving gravity wave detection*," $198,863 (2007–10).

D. Stinebring, Booth-Ferris Foundation "*OCCaM award*," $150,000 (2006-2008).

Publications (undergraduate co-authors underlined)

S.A. FitzGerald, K. Allen, P. Landerman, J. Hopkins, J. Matters, R. Myers, and J.L.C. Rowsell, "Quantum dynamics of adsorbed H2 in the microporous framework MOF-5 analyzed using diffuse reflectance infrared spectroscopy," *Phys. Rev. B* **77**, 224301 (2008).

Y. Ijiri, T.C. Schulthess, J.A. Borchers, P.J. van der Zaag, and R.W. Erwin, "Link between perpendicular coupling and exchange biasing in Fe_3O_4/CoO multilayers," *Phys. Rev. Lett.* **99**, 147201 (2007).

M. Sachan, C. Bonnoit, S.A. Majetich, Y. Ijiri, P.O. Mensah-Bonsu, J.A. Borchers, and J.J. Rhyne, "Field evolution of magnetic correlations in ε-Co nanoparticle assemblies," *Appl. Phys. Lett.* **92**, 152503 (2008).

S.M. Burrows, C.L. Martin, and E.A. Roberts, "High-latitude remote sensing of mesospheric wind speeds and carbon monoxide," *J. Geophys. Res. – Atmospheres* **112**, D17109 (2007).

N. Poli, Z.W. Barber, N.D. Lemke, C.W. Oates, L.S. Ma, J.E. Stalnaker, T.M. Fortier, S.A. Diddams, L. Hollberg, J.C. Bergquist, A. Brusch, S. Jefferts, T. Heavner, and Parker, "Frequency evaluation of the doubly forbidden $^1S_0 \rightarrow {}^3P_0$ transition in bosonic ^{174}Yb," *Phys. Rev. A* **77**, 050501-1 (2008).

T. Rosenband, D.B. Hume, P.O. Schmidt, C.W. Chou, A. Brusch, L. Lorini, W.H. Oskay, R.E. Drullinger, T.M. Fortier, J.E. Stalnaker, S.A. Diddams, W.C. Swann, N.R. Newbury, W.M. Itano, D.J. Wineland, and J.C. Bergquist, "Frequency ratio of Al^+ and Hg^+ single-ion optical clocks; metrology at the 17th decimal place," *Science* **319**, 1808 (2008).

A.D. Ludlow, T. Zelevinsky, G.K. Campbell, S. Blatt, M.M. Boyd, M.H.G. de Miranda, M.J. Martin, J.W. Thomsen, S.M. Foreman, J. Ye, T.M. Fortier, J.E. Stalnaker, S.A. Diddams, Y. Le Coq, Z.W. Barber, N. Poli, N.D. Lemke, K.M. Beck, and C.W. Oates, "Sr lattice clock at 1×10^{-16} fractional uncertainty by remote optical evaluation with a Ca clock," *Science* **319**, 1805 (2008).

Z.W. Barber, J.E. Stalnaker, N.D. Lemke, N. Poli, C.W. Oates, T.M. Fortier, S.A. Diddams, L. Hollberg, and C. W. Hoyt, "Optical Lattice Induced Light Shifts in a Yb Atomic Clock," *Phys. Rev. Lett.* **100**, 103002 (2008).

S.M. Foreman, A.D. Ludlow, M. de Miranda, J.E. Stalnaker, S.A. Diddams, and J. Ye, "Coherent optical carrier transfer over a 32-km fiber with long-term instability < 10^{-17}," *Phys. Rev. Lett.* **99**, 153601 (2007).

J.E. Stalnaker, S.A. Diddams, T.M. Fortier, K. Kim, L. Hollberg, J.C. Bergquist, W.M. Itano, M.J. Delany, L. Lorini, W.H. Oskay, T.P. Heavner, S.R. Jefferts, F. Levi, T.E. Parker and J. Shirley, "Optical-to-microwave frequency comparison with a fractional uncertainty of 10^{-15}," *Appl. Phys. B* **89**, 167 (2007).

T. Rosenband, P.O. Schmidt, D.B. Hume, W.M. Itano, T.M. Fortier, J.E. Stalnaker, K. Kim, S.A. Diddams, J.C.J. Koelemeij, J.C. Bergquist and D.J. Wineland, "Observation of the $^1S_0 \rightarrow {}^3P_0$ clock transition in $^{27}Al^+$," *Phys. Rev. Lett.* **98**, 220801 (2007).

J.E. Stalnaker, Y. Le Coq, T.M. Fortier, S.A. Diddams, C.W. Oates and L. Hollberg, "Measurement of excited-state transitions in cold calcium atoms by direct femtosecond frequency-comb spectroscopy," *Phys. Rev. A* **75**, 040502(R) (2007).

T.M. Fortier, N. Ashby, J.C. Bergquist, M.J. Delaney, S.A. Diddams, T.P. Heavner, L. Hollberg, W.M. Itano, S.R. Jefferts, K. Kim, F. Levi, L. Lorini, W.H. Oskay, T.E. Parker, J. Shirley and J.E. Stalnaker, "Improved limits on variation of the fine structure constant and violation of local position invariance," *Phys. Rev. Lett.* **98**, 070801 (2007).

M.C. Stowe, M.J. Thorpe, A. Pe'er, J. Ye, J.E. Stalnaker, V. Gerginov and S.A. Diddams, "Direct Frequency Comb Spectroscopy" in: *Advances in Atomic, Molecular Physics and Optical Physics* ***55***, E. Arimondo, P. Berman, C. Lin, Eds. Elsevier (2007).

K. Tsigutkin, J.E. Stalnaker, D. Budker, S.J. Freedman and V.V. Yashchuk, "Towards measuring nuclear-spin-dependent and isotopic-chain atomic parity violation in Ytterbium," in *From Parity Violation to Hadronic Structure and more...*, Ed. by K. de Jager *et al*, Springer (2007).

D.A. Hemberger and D.R. Stinebring, "Time variability of interstellar scattering and improvements to pulsar timing," *ApJ*. 674, L37 (2008).

D.F. Styer, "How do two moving clocks fall out of sync? A tale of trucks, threads, and twins," *Am J Phys* **75**, 805 (2007).