Physics Careers in Government Agencies

by

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Agenda

- Who Am I?
- Where Do I Work?
  - Department of Commerce
  - NIST
- What Does NIST do?
- What Is a Physicist?
  - Education
  - Characteristics of Physicists
- Physicists in the Federal Government
  - Finding a Job
- Career Advancement at NIST
- How Did I Get Here?
- Reflections from a Government Physicist
- Summary
Why Should You Listen to Me?

- Worked for the same Federal Agency (NIST) for the past 22 years and spent 1 year at the National Science Foundation
- Currently holds leadership role (Division Chief) at the National Institute of Standards and Technology
- Made a mid-career transition from University work to Government work – unique perspective on both career paths
- I am excited to be here today and share my physics career experiences in the government with you
The historic mission of the Department is "to foster, promote, and develop the foreign and domestic commerce" of the United States. This has evolved, as a result of legislative and administrative additions, to encompass broadly the responsibility to foster, serve, and promote the Nation's economic development and technological advancement.
President’s Science and Innovation Plan

- The President’s budget recognizes that NIST is a capable partner that is strategically positioned to help the Nation improve its innovation performance and respond effectively and efficiently to national priorities.
  - Double NIST laboratory/construction budget
  - Growth of Hollings MEP Program
  - Growth of Technology Innovation Program

- NIST programs align well with Presidential priorities:
  - Smart Grid
  - Health IT
  - Cyber-security
  - Manufacturing
  - Innovation and competitiveness
National Institute of Standards and Technology

NIST Mission
- To promote U.S. innovation and industrial competitiveness by advancing
  - measurement science,
  - standards, and
  - technology
- in ways that enhance economic security and improve our quality of life

NIST Assets Include:
- 2,900 employees
- 1,800 associates
- $843 million operating budget
- NIST Laboratories – National measurement standards
- Manufacturing Extension Partnership
- Baldrige National Quality Award
- Technology Innovation Program

“…NIST is the only Federal research agency with the express mission of working with industry to keep US technology at the leading edge…”
- Science for the 21st Century, July 2004
The NIST Laboratories

NIST’s work enables

• Science
• Technology innovation
• Trade
• Public benefit

NIST works with

• Industry
• Academia
• Other agencies
• Government agencies
• Measurement laboratories
• Standards organizations
Advanced Standards: The Electronic Kilogram

Project Goals:

• Realize the electrical unit of voltage and provide an alternative definition of the unit of mass that is based on measured quantities determined by fundamental physical constants of nature.

• Realize the unit of Force in the International System of Units (SI) through the electrical units at the nanonewton level; provide calibrated force artifacts for research groups and industry.

• Establish intrinsic force standards of nature at the nanonewton level traceable to the SI.
NIST's atomic clock in Boulder, Colorado, serves as the ultimate standard for setting every wristwatch, every wall clock, every computer clock.

The NIST F1 atomic clock which was developed, maintained, and improved by NIST, provides a time standard crucial for the leading edges of military and civilian technology and of science. It will neither gain nor lose one second in 60 million years.

www.time.gov receives billions of hits daily.

NIST is collecting data on two next-generation clocks: a mercury-based clock and an aluminum-based one (see left picture). Both clocks were built at NIST and both are at least 10 times more accurate than the current U.S. time standard, which is based on NIST’s F1 atomic clock.

Adjusting the quantum logic clock, which derives its “ticks” from the natural vibrations of an aluminum ion (electrically charged atom).
Neutron-based measurements are critical for 21\textsuperscript{st} century innovation

- Determining the structure of materials and devices at the nanometer scale
- Discovering advanced new materials for technologies beyond semiconductors

- NCNR is the most reliable, most capable & most used facility for cold neutron research in the United States, serving over 2000 research participants per year

Neutron Techniques

- Crystallography, reflectometry, small angle neutron scattering, spectroscopy, chemical analysis, and other methods (including interferometry, radiography, and fundamental physics)

Center for High Resolution Neutron Scattering (CHRNS)

- Is a joint NSF/NIST national user facility within NCNR for use by the general scientific community

www.nist.gov/ncnr/
NIST Nobel Prizes for Physics

John L. (Jan) Hall, 2005
... for contributions to the development of laser-based precision spectroscopy, including the optical frequency comb technique

Eric A. Cornell, 2001
... for research leading to the landmark 1995 creation of the Bose-Einstein condensate and early studies of its properties

William D. Phillips, 1997
... for development of methods to cool and trap atoms with laser light
Physics – What Is It?

- Physics is the basis of science and technology. It deals with how and why matter and energy act as they do.
- Physics is a passport into a broad range of science, engineering, and education careers.
- People then tend to specialize
  - Astrophysics, solid state, quantum, space, applied, medical, bio, nuclear, geo, health, laser, elementary particle, theory, nano, etc.
- Physics is often driven by a strong curiosity combined with a process of ongoing learning – delve down into the underlying reasons why and how things work.
- Many physicists are attracted by the fact that they have a chance to break new ground, a lot of what happens and a lot of what they work on has not been done before by anyone. It’s often all new, frontier work.
What is a Physicist?

- The physicist deals with all aspects of matter and energy.
- Categories for the study of physics:
  - Motion and properties of physical objects both large and small (classical and quantum mechanics, astrophysics),
  - Properties of waves (optics, acoustics, electromagnetics),
  - Properties of states of matter (solid state, plasma physics),
  - Fundamental properties of matter and energy (atomic, nuclear, and particle physics),
  - Specialization in theoretical and/or experimental work.
- Physics studies range from basic research of the fundamental laws of nature to the practical development of semiconductor devices & instruments, as well as the development of standards that enable commerce.
Undergraduate Training

Broad Exposure in Physics

- Mechanics
- Electrostatics
- Electricity and Magnetism
- Heat and Thermodynamics
- Optics
- Solid State Physics
- Nuclear Physics
- Principles of Quantum Mechanics
- Good background in Mathematics
- Life sciences and Engineering Basic Courses
Graduate Training

Specialize

Develop discipline to formulate and carry out independent research

- Study advanced courses
- Choose a thesis topic
- Develop a research plan
- Set up the equipment (Experiment)
- Run the experiment
- Collect data
- Analyze the data
- Make empirical deductions
- Develop theory & model
Physicist Qualities or Abilities Deemed Valuable

- Planning, organizing, and conducting research
- Problem solving
- Intellectual and personal creativity/imagination/inventiveness
- Working with a complex body of knowledge
- Working with computers
- Using advanced mathematical formulas and concepts
- Communication of one’s ideas in spoken and in writing essential
- Teamwork spirit and ability to work cooperatively with others
- Versatility
- Applying abstract theories to practical problems
- Understanding and applying the scientific method
- Doing detailed work accurately and consistently
- Developing new technologies
- Honesty in dealing with data, theory, and colleagues

**Physicists tend to be curious, creative, and dedicated.**
Physics offers challenging, exciting, and productive careers. As a career, physics covers many specialized fields -- from acoustics, astronomy, and astrophysics to medical physics, geophysics, and vacuum sciences.

Physics offers a variety of work activities—lab supervisor, researcher, technician, teacher, manager. Physics opens doors to employment opportunities throughout the world in government, industry, schools, and private organizations.

from www.aip.org/careersvc/pify/indigo.html
For a general view, see the section on Physicists (www.bls.gov/oco/ocos052.htm):
Most Important Aspects of Physics Education in Shaping Careers of Government Employees

- **Analytical skills** – ability to identify the problem and provide solutions, disciplined way of thinking, logical thinking, taught me to question everything and to look at facts in making decisions

- **Physics knowledge** – a broad based understanding of the physical world, established me as a technical generalist, prepared me to look at systems and processes outside the field of physics, breadth of subjects covered

- **Technical knowledge** – learned very marketable and useful skills, e.g., laboratory experience, computing experience

- **Personal traits** – mental discipline and perseverance skills gained from applying myself, dedication in working with others, gained confidence to take on things I don’t completely understand

- **Role model and personal contacts** – advice, counseling, and giving perspective from advisor, professors that knew their subjects thoroughly, loved their work, and made it interesting and challenging, contacts and acquaintances made in college
Physicists Are Diversified

Because of their broad scientific background, physicists in government branch out into engineering fields and other scientific fields, working with engineers and other scientists in overlapping areas. Physicists are known for their ability to work in many areas and have helped create many non-traditional fields.

See Summary Report 19-2012.00 for Physicists from O*NET OnLine (online.onetcenter.org/link/summary/19-2012.00)
Government Positions for US Physicists

- Employ about 25–30% of all US Physicists
- National Aeronautics and Space Administration (NASA)
- National Science Foundation
- Nuclear Regulatory Commission
- Department of Commerce
  - NOAA, NIST
- Department of Health and Human Services
  - NIH
- Department of Energy
  - Office of Basic Energy Sciences, National Labs (Sandia, Brookhaven, Oak Ridge, National Renewable Energy Lab, Lawrence Berkeley, Los Alamos, Livermore, Argonne, etc)
- Department of Defense
  - Naval Research Lab, Army Research Lab, Wright-Patterson Air Force Base, etc.
Government Positions for Physicists

- Ph.D. Level: basic research and development
- Master’s Level: Qualify for many jobs in applied research and development
- Bachelor’s Level: Often qualify as technicians, research assistants, or other types of jobs
- Many physicists branch out beyond R&D work into management/leadership positions; e.g.,
  - David Seiler, NIST, Chief of Semiconductor Electronics Division
  - Patrick Gallagher, NIST, Director
  - Steven Chu, Secretary of Energy, DOE
  - William Brinkman, Director of Office of Science, DOE
Finding a Job in Government

Track Science & Technology Advances
- Subscribe to Technical and Professional Journals
- Read science & technology sections of NY Times & Wash. Post
- Websites of Professional Societies (AIP, APS, IEEE etc.)

Align Your Expectations With Reality
- Check government job websites to find out who is hiring
  - www.usajobs.gov
- Read budget projections to see who might have money to hire (align your expectations with reality)

Network, Network, Network
- Attend meetings (talk with people, get to know new people)
- Place calls to known contacts (professors, peers, colleagues)
- Investigate Summer Undergraduate Research Fellowship (SURF) and National Research Council and the NIST Postdoctoral Research Associateships Program
  - SURF - www.surf.nist.gov/surf2.htm
  - Postdoctoral Program - http://sites.nationalacademies.org/pga/rap/
  - NIST-specific Postdoctoral Program - www.nist.gov/oiaa/postdoc.htm

Resume
- Emphasize coursework & lab skills
- Emphasize breadth of knowledge
- Emphasize your skills
Career Advancement at NIST

- National research Council Post Doc
- Scientific Staff
- Project Leader (2 – 6 staff)
- Group Leader (8 – 20 staff)
- Division Chief (20 – 70 staff)
- Laboratory Director (80 – 300 staff)
- NIST Director (appointed by president)
Scientific Staff

- Technical excellence (analytical ability, expertise, publications, impact, etc)
- Communication skills
- Adaptability
- Teamwork
- Customer focused
- Creativity & imagination
Project Leader

- Leadership and vision for project
- Effective use of resources including staff and funds
- Promote visibility
- Mentor staff
- Manage conflict productively
- Ensure project safety
Group Leader

- Technical & financial leadership
- Achieve high impact for projects
- Strategic planning for multiple Groups
- Serve on Division management team
- Supervisory responsibilities
  - Develop performance plans and conduct employee appraisals
  - Promote learning and professional/career development of staff
  - Ensure timely submission of reports
Division Chief

- Provide overall leadership to Division
- Develop and implement strategic plans
- Set and drive vision & goals
- Oversee evaluation & promotion of staff
- Develop future leaders
- Ensure smooth administrative operations
- Monitor and control Division financial performance
Evolution of a Career
(*LIFELONG LEARNING – STAGE ONE*)

**Started in K – 12**
Interest in science (rock collecting) and math (doing extra homework)

Undergraduate Studies - Case Western Reserve University
- Tuition Scholarship Awarded
- 1\textsuperscript{st} year excellent physics professor in a recitation section
- 2\textsuperscript{nd} year – chose physics major
- Loved experimental lab work throughout
- 4\textsuperscript{th} year – developed interest in solid state physics
- 1\textsuperscript{st} paper published on Thin Films

Graduate Studies – Department of Physics, Purdue University
- Teaching & Research Assistant
- Loved problem solving in coursework
- Thesis Research – allowed me the freedom to develop discipline and character traits to do fundamental research. Identify thesis topic and necessary ingredients to complete thesis and publish papers
Evolution of a Career
*(LIFELONG LEARNING – STAGE TWO)*

- **Assistant Professor, Department of Physics, University of North Texas (UNT), Denton, TX**
  - Teach solid state physics and an advanced senior undergraduate laboratory course
  - Do research and supervise students in semiconductor physics

- **National Bureau of Standards, Boulder, Colorado**
  - InSb spin flip Raman laser
  - Learned to build and operate CO and CO2 infrared lasers

- **Associate Professor, Department of Physics, University of North Texas (UNT), Denton, TX**
  - Build IR lasers and use to study semiconductors
  - Start quantum electronics programs, teach laser courses, hire new professors
  - Laser induced hot electrons
  - Begin two photon absorption studies

- **Research Scientist, Massachusetts Institute of Technology National Magnet Lab, Cambridge, MA**
  - Dye and YAG lasers used to study two photon effects in semiconductors

- **Professor, Department of Physics, University of North Texas (UNT), Denton, TX**
  - Two photon spectroscopy, impurity and deep level spectroscopy

- **Program Director**
  - **Solid State Physics Program, Materials Research Division, The National Science Foundation (NSF), Washington, D.C.**
Evolution of a Career
(LIFELONG LEARNING – STAGE THREE)

Started a new career in government*

National Institute of Standards and Technology (Since 1988)

- Materials Technology Group Leader
  Semiconductor Electronics Division, National Institute of Standards and Technology (NIST)

- Program Analyst
  Program Office for the Director of NIST, National Institute of Standards and Technology (NIST)

- Division Chief, Semiconductor Electronics Division
  National Institute of Standards and Technology (NIST)

* Be willing to take risks and do something different
Reflections on My Management Philosophy

- Set realistic goals for yourself to achieve
- Never stop learning about yourself, your job, and the people you work with
- Motivating and empowering people are the most important facets of managing
- Expect excellence and quality from your staff
- Be a role model for what you “preach”
- Provide the proper environment that nourishes and stimulates creativity
- Listen well and communicate effectively
Reflections from a Government Physicist

- Challenges exist ‘tis true – bureaucracy, people management, ...

BUT STILL MANY OPPORTUNITIES EXIST:
- To do excellent research
- To be creative and innovate
- To demonstrate leadership
- Great opportunity to achieve high impact on problems of national importance
- Unique opportunities to collaborate both with industry and academia
- Enhances the technical expertise and reputation of the government and, in turn, the country
- Wide variety of mentorship opportunities
- Wide flexibility in career options

In summary, I have found my work in the government to be both challenging and satisfying
Summary

- Knowledge, innovation, and hard work are necessary for getting a job and for your career advancement.
- Well-educated people possess a foundation of knowledge and know how to learn more.
- Creative people innovate.
- You have to continue to learn if you want to keep innovating.
- Motivated people accomplish more and faster.
- Research universities graduate such people
  - learn from people who are on cutting edge.
  - learn how to formulate and attack problems not previously solved.