A Career in Physics?

Of Course!

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What is a Physicist?

The definition of a physicist is fuzzy – a few choices:

- Dictionary:

  A specialist in physics, a science that deals with matter and energy and their interactions in the fields of mechanics, acoustics, optics, heat, electricity, magnetism, and radiation.

- Someone with a Ph.D., M.Sc. or B.Sc. in Physics, Physics and Mathematics, etc.

- Someone trained to observe/ study physical "phenomena"
  - Phenomena related to the underlying structure of our world
  - Separate from specialized areas such as Chemistry, Geology, or Astronomy

- Someone with the mathematical skills to interpret observations and place them in the context of a "model" or "theory"

Perhaps the most accurate definition is someone who

- wants to know how the world works

- use observational and theory to improve that understanding

$\Rightarrow$ A problem solver!

Problem Solving as a Career!

Physicists are basically technically literate problem solvers

- Have an advanced technical training
  - Expected to know how to tackle pretty much any sort of new problem
  - Have the know-how and experience to not be afraid of any tools
    - Instrumentation for measurement or observation
    - Electronics, lasers, particle detectors, sensors
    - Data acquisition and analysis tools, computers

- Have training to think creatively and abstractly
  - Creativity is essential – way to generate "knowledge"
  - Abstract thinking needed for "model-building" process
  - Observations are only useful to a physicist if they can be used to fine-tune an existing model, or develop a new one

This will come clearer in a few examples

Jobs for Physicists

Physicists are found in a large variety of roles

- Traditional roles are in academia and research
  - Professors in universities $\Rightarrow$ research & teaching
  - Research scientists at universities or government labs

- More frequently found in the private sector
  - Research scientists involved in
    - Basic research focussed on certain technologies, eg.
      - HP laser printer technology
      - Tomography for MRI and PET scanners
      - Lasers for grocery scanners and CD players
    - Technologies where principles "understood," eg.
      - Sensors for oil well "logging" (Schlumberger-Doll)
      - Long range weather forecasting (Environment Canada)
      - Power transmission technology (Ontario Hydro)
    - Modelling and analysis of "phenomena," eg.
      - Nuclear reactor safety issues
      - Searching for mineral and oil deposits
      - Financial markets (Wall Street and Bay Street)!
  - Probably takes in about 60-70% of trained physicists

$\boxed{\textbf{Diversity of Physics}}$

Physics is a very diverse field, eg. at U of T

- Quantum Optics (lasers!)
  - Making higher power lasers
  - Making more precise lasers

- Condensed Matter Physics
  - properties of materials
  - unique behaviour (eg. high T_C)

- Planetary Physics
  - Study of seismic waves
  - Effect of glaciers on the earth's surface

- Atmospheric Physics
  - creation of storms
  - atmospheric pollution
  - Effect of glaciers on the earth's surface

- Subatomic Physics
  - exploring the interior of atoms
  - Figuring out how our universe works

Laser Physicist

Lasers now appear to be ubiquitous

- Probably have at least one in your home or workplace...
  - CD players
  - Some smoke detectors or alarm systems
  - Grocery scanners
  - Laser light shows....

- At U of T, have a large laser ("quantum optics") group
  - Do research in basic physical properties involved in lasing or using lasers
    - Developing techniques for "trapping" atoms
    - This line of research just won Nobel Prize in Physics last year
  - Also working with various companies
    - Lumonics Corporation has a "chair" in physics
    - Working on developing high power lasers on the cheap

Department has five laser labs, each with many different set-ups looking at different phenomena

- Each optics table has different experiment going on
- May take months to get it right

Typical Day for a Quantum Optician...

Typical day involves

- Come in and warm up the research laser
  - Look at last nights results – figure out what might have gone wrong
  - Talk to supervisor or students
- Set up and do another set of measurements
  - Try to understand results
    * If they look OK, move on to next possible problem
    * If not, think about what might still be wrong
  - If they look "wierd," think about how to confirm them
    * Try to reproduce them
    * Think about ways of mimicing the result
- Later in day, check to see if anything new has come into the library
  - Have a break to talk to colleagues
  - Check on results of other experiments

Typically are working on several things simultaneously

Another Typical Day – Particle Physicist

Come in and read e-mail

- I get typically about 30-40/day associated with research
- Catch up on stuff I can do immediately

Have weekly group meeting

- Meet and discuss progress in last week
- Bring up any issues or problems, eg.
  - Out of disk space on local workstation cluster
  - Somebody found software bug - has anybody else seen it?
  - Schedule time to review a paper
- Go around the "table," report on projects
  - Students and staff will report on their own research work
  - Keep everybody up-to-date
  - Give everybody a chance to comment and advise

More on My Typical Day...

Spend couple hours in instrumentation lab

- Working on developing a small “inchworm” to very precisely precision a big detector
  - Have had problems making it strong enough
  - Worked with engineers and machinists to improve it
- Also have several other “hardware” projects underway
  - Work on microelectronic circuits
  - New types of particle detectors

Later in day, meet 1-on-1 with other researchers to discuss progress

- Sometimes will sit down and go over data analysis
- Go over drafts of papers

Why So Appealing?

Always learning new things

- Advancing our knowledge about how world works
- Latest advances in high speed computing and communications
- New technologies

Interact with some very bright and pleasant people

- Not just a bunch of "nerds"
- Real people with similar passions about discovery
- Intellectually challenging

Often pretty competitive

- Want to be "first" to get there
- Want to be able to make progress the fastest
- Sometimes this is not so much fun – stressful!

Compensation and Career Development

Starting salaries for Ph.D. physicists vary great deal

- Research associates start around \$30,000 to \$45,000
- Assistant Professors start around \$50,000 to \$65,000
  - Increase by about 2-6%/year depending on performance
- In industry, starting salaries are similar, but peak earlier
  - Most large private employers recognize that research scientists should follow pattern similar to academia

Cost of getting a degree outweighed by higher salary

- But it does require some patience and devotion
- Can take up to 10 years of university education

Longer term career prospects are varied

- Academic stream is very stable on average
- Research scientists also have very low turn-over
- For B.Sc.'s in Physics, experience will vary depending on particular field
  - Degree considered very useful
  - Survey asking to rank usefulness between 1-5
    - Ph.D. on average ranked it as 4.2 ± 1.0
    - M.Sc. on average ranked it as 4.0 ± 1.4
    - B.Sc. on average ranked it as 3.1 ± 1.3

Education and Training

First step is OAC credits in MAT (all 3!) and PHY

- Must at least be comfortable with mathematics
- Curiousity and fooling around with gadgets is a plus

Second step is completion of B.Sc. in Physics, Math & Physics, Astronomy & Physics, etc.

- Provides experience and basic tools to function as a researcher or problem solver
- However, modest amount of real research experience
  - People who complete at this stage go into technical areas
  - Typically, are not involved in research-oriented careers
- Good training ground for people who want to become
  - technician in a research laboratory,
  - enter a related postgraduate degree,
  - a science or math teacher (note: ETP),
  - involved in IT industry

Beyond the B.Sc.

Half of U of T students go on for postgraduate degrees

- Some complete 1 or 2-year M.Sc.
  - Provides greater degree of hands-on research experience
  - Most students do not choose this path unless very specific goals

- Majority of our students go on for Ph.D.
  - Takes about 4-5 years
  - Supported at the level of about $15,000-$22,000 in scholarships and research assistanceships
  - Takes a lot of hard work...
    * One to two years of course work
    * Three to four years of research work
    * Culminates in Ph.D. dissertation

Supply and Demand

Demand is important criteria in choosing a field

- Canada annually produces
  - about 650 B.Sc. physicists
  - about 220 B.Sc. physicists
  - about 120 Ph.D. physicists

- Unemployment rate is virtually unmeasurable
  - Appears to be less than about 2%
  - Results come from recent surveys by CAP and NSERC
- All of these indicate strong demand for people with Physics degrees

This reflects the utility of a degree in Physics

- Professional problem solvers
- Trained to tackle toughest research problems
- Very versatile technically

Summary

Physics is not just a career – it is a way of thinking

- Allows one to be both creative and analytical
- Very stimulating and intellectually challenging
- Opens up a variety of doors in many fields

Remains the place where discoveries will continue to be made

- Academic research is still very challenging
- Private sector continues to play a significant role

Job prospects look quite good

- Strong demand both in academia and in industry
- Versatility is a big bonus in the private sector
- Employment rates are very high

Physics is both Fun and Challenging