Why is it so?

Why are there sunspots?
Why do boomerangs come back?
Why do networks of neurons remember?
Why are some bacteria magnetic?
Why does the earth have a magnetic field?
Why does snow sparkle?
Why do guitars sound differently from violins?
Why is there Dark Matter and Energy?
Why is it so?

Without diversity of thought and perspective among scientists, you get nothing but classical music. When you let different people create different music, you get things like rock 'n' roll, jazz.
Our Research Areas

- Astronomy & Astrophysics
- Biology and Soft Condensed Matter
- Condensed Matter
- Medical Physics
- Subatomic and Particle Physics
- Theoretical Physics
Groups and People

Biophysics and Soft Condensed Matter:
W. Ens, F. Lin, J. Page, R. Roshko, J. van Lierop

Condensed Matter: J. Burgess, C.M. Hu, J. van Lieop, J. Page, J. Sirker, B. Southern, R. Stamps


Education and Pedagogy: R. Cameron, D. Pahud, J. Mammei, R. Hechter


Some Highlights
Neutrophils were attracted to the breast cancer microenvironment mimicked in the microfluidic device. Such chemoattraction was reduced by netrin-1, suggesting an interesting therapeutic target. This study was in collaboration with the Stetefeld group and the McKenna group in the Chemistry Department. Adv. Bio. 2018
Profs. Shelley Page, Micheal Gericke, Jim Birchall: Q-Weak Searches for New Physics

IN THE Q-WEAK COUNTING ROOM, LEFT TO RIGHT: JIM BIRCHALL, SHELLEY PAGE, MICHAEL GERICKE.
Prof Can-Ming Hu: Cavity Magnonics

- “wifi” spin current
- locally probing CMP
- CMP superfluidity (?)

spintronics

- dressed polaritons
- light-matter interaction
- CMP Bose-Einstein condn. (?)

polaritons

- qubit-magnon coupling
- single magnon detection
- quantum magnetism (?)

quantum

IEEE 2018 DISTINGUISHED LECTURER!
Astronomy & Astrophysics:

The CFI collaboration
Unlocking the Radio Sky with Next Generation Survey Telescopes

Canadian Members

International Partners

Exciting Astrophysics Era!
“multi-messenger” astrophysics with light and gravitational waves!

2017 Aug 17
GW170817
(detected across the electromagnetic spectrum!)

Credit: S. Safi-Harb
Theory & Simulation
J. Sirker, R. Stamps, I. Proskurin

Frustration & Quantum Spintronics

Frustration
Spin Glass

Symmetry
Multifunctional materials

Transport
Chirality & electronic states

Spin waves & magnonics
GHz & THz
Want a job?

STATUS OF ASTRONOMY & PHYSICS BACHELOR RECIPIENTS ONE YEAR AFTER DEGREE

98% Employed
2% Unemployed

One half of the bachelor’s degree recipients from the classes of 2010 to 2012 directly entered the workforce and half went to graduate school. The employment rates were 97 - 98% for the first group, and 99% for those with graduate degrees.

Source: www.aip.org/statistics
Which job do you want?

21st-CENTURY CAREERS

**FIGURE 1. THE PRIVATE SECTOR** employs 65% of physics bachelors who entered the workforce after receiving their degrees, according to a survey of graduates from 2013 and 2014. (This chart does not include the 54% of all degree recipients who entered graduate school immediately.) College and university employment refers primarily to staff, not faculty, positions. “Other” employment includes elementary and middle schools, hospitals and other medical facilities, and nonprofit organizations. In the private sector, the graduates are primarily employed in STEM (science, technology, engineering, and mathematics) jobs, though a significant fraction are employed in non-STEM fields, such as finance and the service industry. (Adapted from ref. 4.)
WISH LIST: SKILLS THAT GRADUATES NEED MOST FOR THE DIGITAL AGE

Qualities needed
Satisfaction with current graduates’ levels of these qualities

Note: Respondents ranked each area on a six-point scale. The graphic shows the percentage of respondents picking values five and six for each area, with six being the most important.

www.timeshighereducation.com
What does Physics give you?

Physicists are trained as master PROBLEM SOLVERS.

Physicists ADAPT discoveries to create new technologies.

Physicists see the BIG PICTURE of overlaps between chemistry, biology, math, etc..
We are able to COMMUNICATE across disciplines.
Some U of M Graduates

- J. Z. (PhD Physics) Medical Research
- M. Z. (MSc Physics & Astro) Investment Management
- I. Y. (MSc Physics) Hospital & Health Care
- Y. H. (MSc Physics) Electrical Engineer
- B. W. (PhD Physics) Medical Research
- R. W. (BSc Math & Physics) Canadian Armed Forces
- M. W. (BSc Hons Physics) Medical Devices
- G. W. (PhD Physics) National Research Council
- G. W. (MSc Geophysics) Oil & Energy
- C. W. (BSc Hons Physics) Environment and Sustainability
- Z. W. (BSc Physics) Finance
- J. W. (MSc Physics) Hospital and Health Care
- M. V. (BSc Physics & Math) Education Management
- J. V. (PhD Physics) TRIUMF
- P. U. (PhD Physics) Medical Imaging
- R. T. (MSc Physics) Business Management Consultant
- V. S. (BSc Physics) Technician
- L. B. (BSc Physics) Information Technology
Questions?
Physics *teaches* you how to *think* in a way that *solves* problems

... many different *kinds* of problems
What will your title be?

21st-CENTURY CAREERS


**FIGURE 3. COMMON JOB TITLES** reported by physics bachelors from the classes of 2009 and 2010. (Adapted from the careers toolbox for undergraduate physics students, AIP Career Pathways Project, www.spsnational.org/careerstoolbox.)
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Physicists **ADAPT** discoveries to create new technologies.

Physicists see the **BIG PICTURE** of overlaps between chemistry, biology, math, etc..

We are able to **COMMUNICATE** across disciplines.
Physics
-and research in physics—only prepares you for research
Physics: Why is it so?

... people of all ages ... in all walks of life ... enjoy what I call THE INTELLECTUAL GYMNASTIC. It is in the nature of the human creature to THINK, and what the human mind prospers on is something to think ABOUT ...
What do employers want?
The program is intended for students who wish to learn Physics as part of a general education, or combine physics with other disciplines. There are many options with this degree which might include a career in education, high technology, business, or science journalism.

The large number of electives will allow the students to obtain a significant background in another field such as Chemistry, Life Sciences, Computer Science, Mathematics, Physical Geography, Geophysics or Geology.

In some cases, these can be recognized formally as a minor or part of a double major program. Combined with the proper electives, this program is suitable as pre-training for a professional degree in fields such as Architecture, Commerce, Education, Law and Medicine.
The Physics Major = Many Options

Years 1 and 2:
- introduction to modern physics (Newtonian and quantum mechanics, electromagnetism, special relativity)
- six electives of your choice

Years 3 and 4:
- Third year lab, and four core courses
  - ten electives of your choice

Physics & Astronomy Electives:
- Computational Modelling
- Circuit Theory & Electronics
- Observational Astronomy
- Stars
- Medical Physics
- Optics
- Solid State Physics and many more...

New: CO-OP opportunities!
How do you start?

- PHYS 1050
- PHYS 1070
- PHYS 1020
- PHYS 1030
- Hon. Physics
- PHYS 1810
- PHYS 1030
- Hon. Astro.
My life as a Physicist

BS

Trains: smoother/faster train rail carriage suspensions

Optical media: helped develop first optical CD’s

MS/PhD

Magnetic resistors: helped develop read heads for high density data storage

PhD

Human vision: neural networks and visual perception of movement

Mathematical biology: computer algorithms for swarms and flocks

Artificial magnets: nanotechnology and materials for the future

Management: Microwave lab/Microscopy group
What is Physics?

Physics is what Physicists do!

Professor Richard Feynman
Theoretical Physics
Nobel Prize Quantum
Electrodynamics

Physics is what Physicists do!
Physics and Astronomy is taught by people who make Physics and Astronomy
Why is it so?

What is a physicist?

Physicists are people

...who are curious
Without diversity of thought and perspective among scientists, you get nothing but classical music. When you let different people create different music, you get things like rock 'n' roll, jazz.

Professor Jim Gates
Supersymmetry, String Theory, Super Gravity
...we turned on our detectors on the centenary of the year Einstein’s general theory of relativity was published and at exactly the right time to receive this signal coming to us from 1.5 billion years ago – when far out in the Universe two black holes spiralled in to collide …

Professor Sheila Rowan, MBE
Chief Science Advisor Scotland
Director, Institute for Gravitational Research
Why is it so?

If you think you understand quantum mechanics, you don't understand quantum mechanics.

Professor Richard Feynman
Theoretical Physics
Nobel Prize Quantum Electrodynamics
Physics and Astronomy at U of M: NEW PROGRAM !!!
Snapshot: Astronomy

- Danielle Pahud
- Jayanne English
- Chris O’Dea
- Stefi Baum
- Samar Safi-Harb
- Jason Fiege
- Andreas Shalchi

- Star formation and Death
- Exotic Stars
- Black Holes, Galaxies and Clusters of Galaxies
- Cosmic Rays
- Interstellar Medium
- Computational Astrophysics
Snapshot: Medical and Biophysics

Francis Lin:
Studying cell-cell migratory interactions using microfluidic devices

Stephen Pistoriuss:
CT Scatter Imaging
PET Scatter Imaging
Microwave Imaging / Breast Cancer Detection
Portal Dosimetry
Real Time Organ Tracking and Treatment Optimization
Snapshot: Theory & Computation

R. M. Roshko

• Molecular dynamics of proteins
• Transport of vibrational energy
• Molecular signaling networks

K. Shamsedinne

• Non-Archimedean field analysis
• Power series and analytic functions
• Measure theory and integration
• Differential equations
• Multivariable and functional analysis
B.W. Southern
- Frustrated magnetism
- Magnetic nanoparticles
- Nonlinear spin excitations
- High performance computing

A. Shalchi (theory)
- Solar Wind, Interstellar Medium
- Plasma-particle interactions
- Cosmic Rays
- Coronal Mass Ejection
- Interstellar Shock Waves
Snapshot: Soft Matter & Ultrafast

John Page: Wave Physics of Complex Media

- Acoustic Lévy flights: Travelling of waves mimicking the flight of bees!
- Ultrasound for food science and tomography experiments: noodle and bread dough

Squishy Physics!

Jacob Burgess

- Stroboscopic time-resolved techniques
- Magneto-optical microscopy
- THz light generation and spectroscopy
- THz frequency spintronics
- Ultrafast scanning tunneling microscopy “Atomically resolved movies”
- A chance to help build apparatuses not just use
Snapshot: Nanomagnets & Stuff

J. van Lierop
• experiments and theory in nanoscale magnetism
• interdisciplinary: chemistry, materials and biosystems engineering, medical research

B. Stamps
• theory and computational
• ferroic 'functional' materials
• simulations of complex systems
### Tour: Theory & Computation

<table>
<thead>
<tr>
<th>Name</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. G. Blunden</td>
<td>Subatomic</td>
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<tr>
<td>T. Chakraborty</td>
<td>Condensed Matter</td>
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<tr>
<td>J. Fiege</td>
<td>Astrophysics</td>
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<tr>
<td>P.D. Loly</td>
<td>Condensed Matter</td>
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<tr>
<td>T. A. Osborn</td>
<td>Mathematical Physics</td>
</tr>
<tr>
<td>A. Shalchi</td>
<td>Astrophysics</td>
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<tr>
<td>K. Shamseddine</td>
<td>Mathematical Physics</td>
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<tr>
<td>J. Sirker</td>
<td>Condensed Matter</td>
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<td>B.W. Southern</td>
<td>Condensed Matter</td>
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<tr>
<td>B. Stamps</td>
<td>Magnetism (Theory and Simulation)</td>
</tr>
<tr>
<td>J.P. Svenne</td>
<td>Subatomic</td>
</tr>
<tr>
<td>J.M. Vail</td>
<td>Condensed Matter</td>
</tr>
</tbody>
</table>

*“Now that desk looks better. Everything's squared away, yessir, squaaaaaared away.”*
True or False?

Physics only prepares you for research
Tour: Theory & Computation

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- Transport of vibrational energy
- Molecular signaling networks

K. Shamsedinne
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- Andreas Shalchi

- Star formation and Death
- Exotic Stars
- Black Holes, Galaxies and Clusters of Galaxies
- Cosmic Rays
- Interstellar Medium
- Computational Astrophysics
Careers in Physics and Astronomy
Kumar S. Sharma
University of Manitoba
Physics and Astronomy Careers

**FIGURE 1.** Except for Architecture and Social Science majors, unemployment rates of recent college graduates in 2011-2012 are less than those of experienced high school diploma workers:

- Agriculture and Natural Resources
- Physical Sciences
- Education
- Industrial Arts, Consumer Services, and Recreation
- Health
- Engineering
- Business
- Biology and Life Science
- Communications and Journalism
- Computers, Statistics, and Mathematics
- Humanities and Liberal Arts
- Law and Public Policy
- Psychology and Social Work
- Arts
- Social Science
- Architecture

Experienced high school diploma holders (18.9%)

Recent high school diploma holders (17.6%)

Source: Georgetown University Center on Education and the Workforce analysis of U.S. Census Bureau, American Community Survey micro data, 2009-2012.
My life as a Physicist

- **Trains**: smoother/faster train rail carriage suspensions
- **Optical media**: helped develop first optical CD’s
- **Magnetic resistors**: helped develop read heads for high density data storage
- **Human vision**: neural networks and visual perception of movement
- **Mathematical biology**: computer algorithms for swarms and flocks
- **Artificial magnets**: nanotechnology and materials for the future
- **Management**: Microwave lab/Microscopy group
Physics and Astronomy Careers

Career Opportunities

Physics and Astronomy graduates are highly sought after employees.

- A physics education emphasizes problem solving and abstract thinking.
- Physics programs offer training in practical subjects like optics, lasers, computer programming and interfacing, image processing and electronics.
- They produce graduates ideally suited to employment in the ever expanding field of high-tech industry.
- This training makes physics graduates very desirable employees in a wide variety of areas.
- Many career opportunities can be found in interdisciplinary fields like medical physics and geophysics.
Physics and Astronomy Careers

INDUSTRIES WHERE GRADUATES ARE EMPLOYED

- 25.8% Research & Development
- 24.1% Teaching
- 12.2% Computing
- 6.2% Health Sciences
- 4.6% Management & Administration
- 4.0% Product Development
- Consulting 4.0%
- 3.4% Sales & Marketing
- 15.8% Other

Source: www.cap.ca/careers

https://www.cap.ca/careers/home/employmentprospects.html