# Quantum Information Science at URI

**Vanita Srinivasa, Program Director**
**Leonard Kahn, Physics Department Chair/Graduate Program Director**

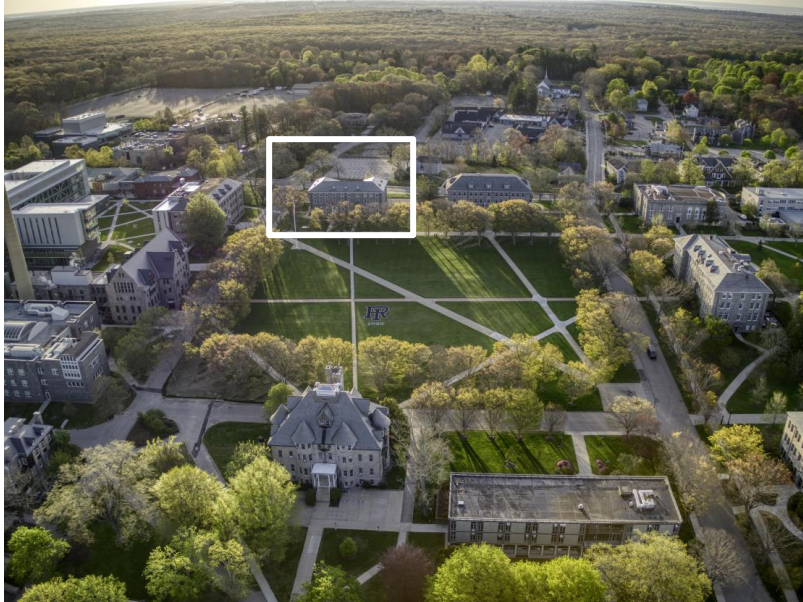THINK BIG WE DO™

# URI Overview



- Flagship public research university of state of RI

- Main campus: Kingston, RI

- Enrollment: ~17,000 students, including > 2,000 graduate students

- Active graduate programs in all STEM disciplines at URI

THINK BIG WE DO™

THE
UNIVERSITY
OF RHODE ISLAND

# URI Department of Physics



- 18 graduate students

- 16 full-time faculty

- Active research programs in biophysics, nonlinear optics, condensed matter physics, statistical physics, and astrophysics

- **Home to new Quantum Information Science (QIS) program**
  - **- 7 faculty and growing**

- **New MS in Quantum Computing (starting in Fall 2021)**

THINK BIG WE DO™

THE
UNIVERSITY
OF RHODE ISLAND

# Jobs in Quantum Information Science

- Quantum industry: Majority hold degree in physics
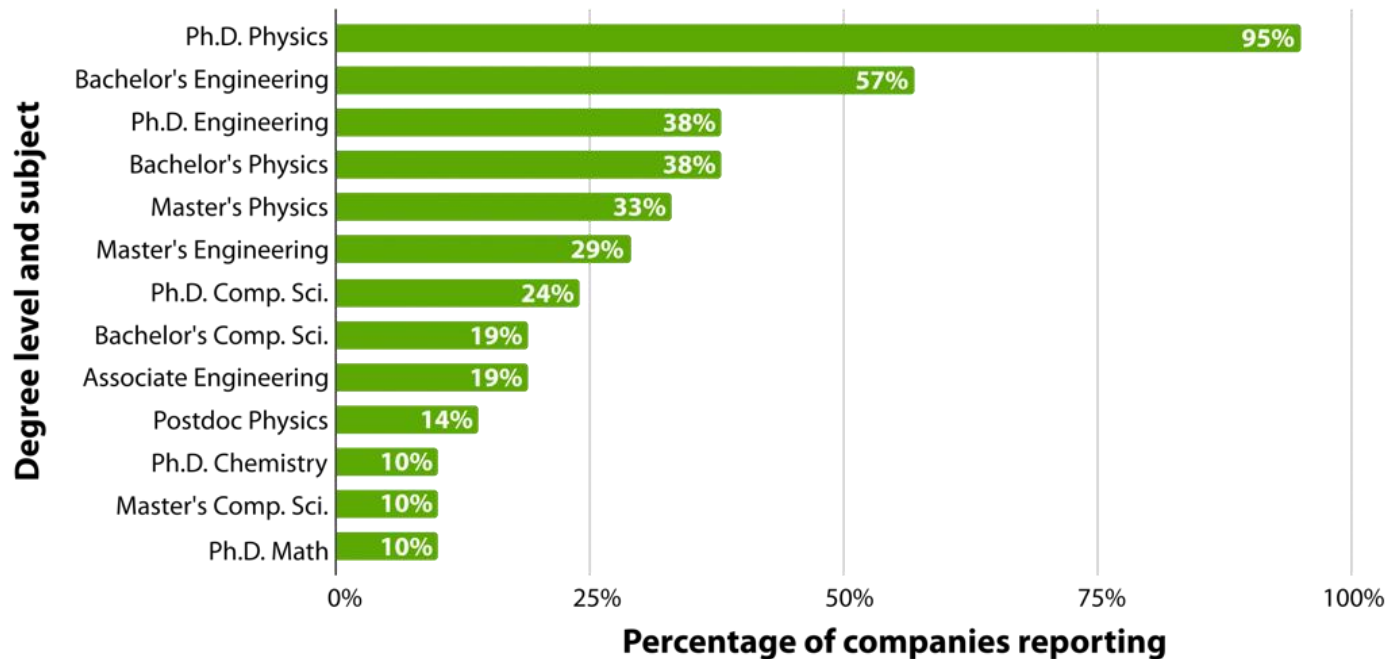


From "Preparing for the quantum revolution - what is the role of higher education?", Michael F. J. Fox, Benjamin M. Zwickl, H. J. Lewandowski

# Quantum Workforce: Key Skills

**Quantum Information Science areas**

- Quantum computing

- Quantum networking and communication

- Quantum sensing and metrology

**Physics skills**

- Fundamental quantum mechanics: Superposition, entanglement, Schrödinger equation, Hamiltonian evolution

- Advanced quantum mechanics: Open system dynamics, physical noise models, decoherence, mechanisms underlying operation of quantum hardware

**General skills (Computer Science, Math)**

- Quantum circuits and algorithms, error correction, statistics, data analysis

# Quantum Computing at URI

**MS degree in Quantum Computing**

- Builds on Physics Department strengths in quantum information science, optics, and nanophysics

- Interdisciplinary curriculum enables connections with Mathematics, Computer Science, Chemistry, and Engineering

- Prepares graduates to become productive members of quantum workforce
    - Engage in developing unique capabilities of quantum computing to realize transformative technologies and generate new knowledge

- Partnering/collaboration with industrial firms, national labs/institutes, and other universities to ensure that our graduates have the required foundation for employment or future studies in this rapidly advancing field
    - Support from Zapata Computing, Cambridge (Christopher Savoie, Founder and CEO)
    - Collaborative research projects with various institutions
    - Proximity to other QIS programs

THINK BIG WE DO™

THE
UNIVERSITY
OF RHODE ISLAND

# Required and Recommended Courses

## Physics

- **PHY451/570/670** Quantum Mechanics
- **PHY455/580/680** Condensed Matter Physics
- **PHY525/625** Statistical Physics
- **PHY530** Electromagnetism
- **PHY510/610** Mathematical Methods
- **PHY591** Research Project

## Mathematics

- **MTH 418** Matrix Analysis
- **MTH/CSC447** Discrete Math
- **MTH472** Numerical Linear Algebra
- **MTH 513** Linear Algebra
- **MTH451** Probability and Statistics
- **MTH462** Functions of a Complex Variable

## Quantum Computing

- **PHY575** Introductory Quantum Computing
- **PHY576** Advanced Quantum Computing
- **PHY577** Quantum Computing Internship

# MS QC Degree: Semester Roadmap

- Five-year program: BS Physics/MS Quantum Computing
- Two-year, non-thesis MS program with one summer internship

| | | | | | | | Credits |
|---|---|---|---|---|---|---|---|
| **Fall 4** | | | PHY525(3) | PHY510(3)/ 610(3) | | MTH513(4) | 10 |
| **Spring 4** | PHY575(3) | PHY570(3) | PHY625(3) | PHY580(3)/ PHY680(3) | PHY530(3) | | 9 |
| **Summer** | PHY577(4) | | | | | | 4 |
| **Fall 5** | PHY576(3) | PHY670(3) | | PHY510(3)/ 610(3) | PHY591(3) | MTH462(3) | 9 |
| **Spring 5** | | | | PHY580(3)/ PHY680(3) | PHY591(3) | MTH451(3) | 6 |
| **TOTAL** | | | | | | | 38 |

**THINK BIG WE DO**

**THE UNIVERSITY OF RHODE ISLAND**

# Quantum Computing Courses

**PHY575: Introductory Quantum Computing**

- Qubits and their physical realization

- Entanglement and Bell states

- Quantum gates and circuits

- Quantum algorithms: Searches, factoring, Fourier transforms

- Quantum information theory

- Introduction to physical implementations

# Quantum Computing Courses

**PHY576: Advanced Quantum Computing**

- Advanced quantum circuit theory

- Decoherence and density matrices

- Error correction

- Teleportation and dense coding

- Cryptography

- Quantum tomography

- Frontiers of physical realizations and quantum hardware

# Quantum Computing Courses

**PHY577: Quantum Computing Internship**

- Hands-on experience in quantum information science
- Students develop internship proposal with set of objectives and statement of work acceptable to the student, as well as the industry/government lab/academic supervisor and the university program director
- May obtain or foster quantum computing internships with any organization, including student's current employer
- Variety of projects possible

# Summary: Quantum Information Science at the University of Rhode Island

- QIS is an ever-evolving field and requires lifelong learning
- Flexibility of URI program: Tailor to student background and interests
- Our goal: Provide strong foundation for success in quantum workforce

**For more information about our program, please contact:**

Vanita Srinivasa – Program Director (vsriniv@uri.edu)

Leonard Kahn – Department Chair (lenkahn@uri.edu)

**To Apply**: https://gradcas.liaisoncas.org/apply/

THINK BIG WE DO™

THE UNIVERSITY OF RHODE ISLAND