Anticipating Audience

in communicating scientific knowledge

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DEPARTMENT OF PHYSICS

I-MRSEC REU COMMUNICATIONS PRESENTATION
2 JULY 2018

The Usual Advice on Communication Planning

Think about your

Purpose

Situation

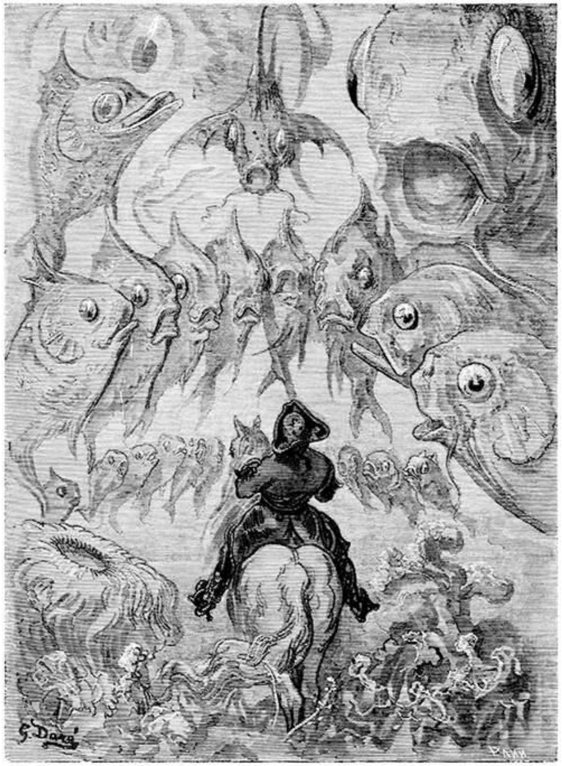
Audience

In order to plan your

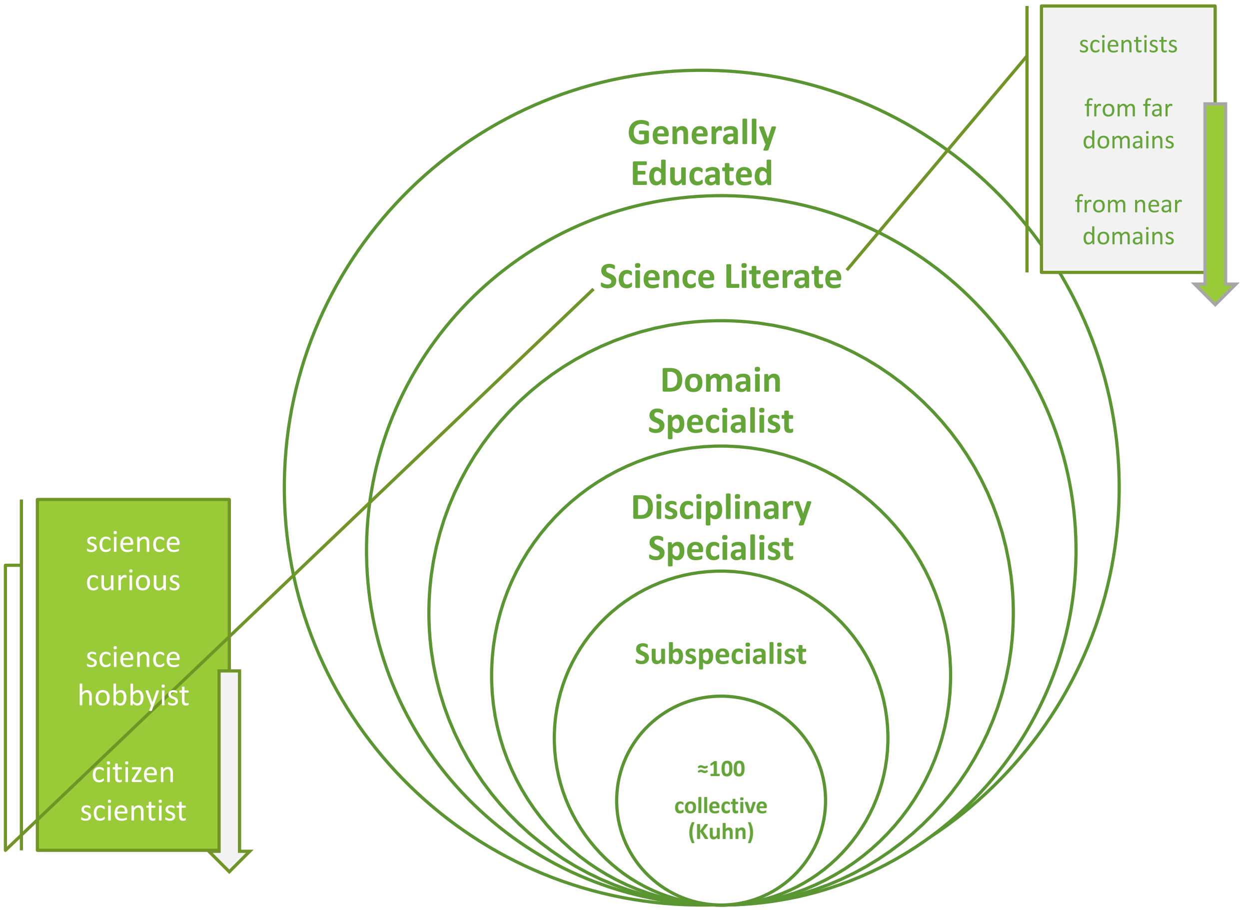
Message

Medium

Approach



Levels of
Knowledge Communities



Shared (culture)
- education
- training
- experience
- goals
- methods
- assumptions
- vocabulary
- genres

Related
- discourse communities
- communities of practice
- professional networks

I. Communicating with Other Experts

Technical Communication

communicating about specialized / technical topics
broadly defined

Scientific Communication

technical communication by scientists for scientists
within same or adjacent field(s) of study

Old View of Science
Positivism

A lone scientist,

pursuing his or her own interests,

investigates a phenomenon,

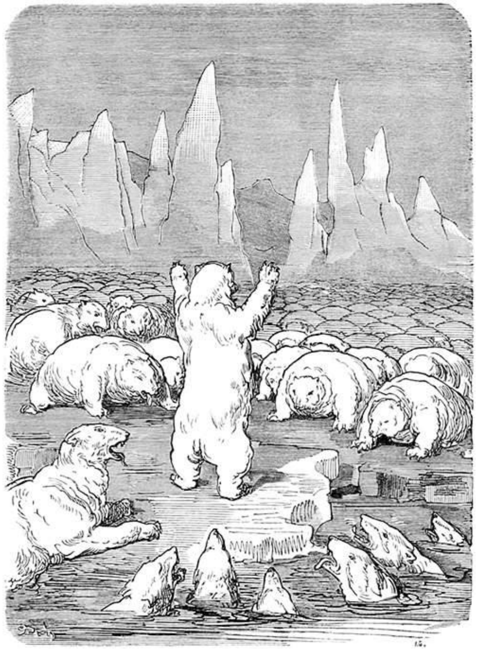
discovers truths, and

announces those discoveries

to other investigators,

who attempt to verify it

and, if so, build upon it.



Purpose of science is to discover truth ("invariable natural laws," "incontrovertible facts"). Core values of scientist: curiosity, drive, originality, and independence.

field of theory:
Sociology of Scientific Knowledge
late 1960s-present
(Thomas Kuhn, Michael Polanyi, John Ziman)

New View of Science
Constructivism (Communitarianism)

Specialists, trained as apprentices

in a shared tradition, using accepted methods,

investigate questions of mutual interest

about phenomena agreed to be of relevance

and present findings to their community

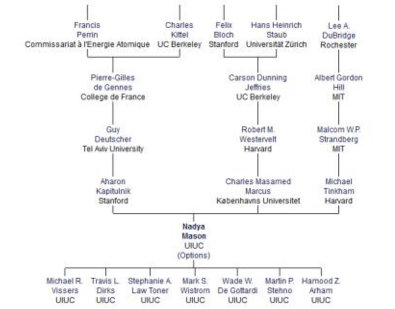
who collectively decide its truth value.

Purpose of science is to build consensus about what is thought to be true. Core values of scientist: curiosity and drive tempered with internalized norms and collective agreement, which are in turn tempered with self-criticism and skepticism.

Research Community Analysis by Researcher

Nadya Mason > Physics
> Experimental > Condensed Matter Physics > Superconductivity, Quantum Computing, Nanomaterials

"…current research focuses on the electronic behavior of materials such as carbon nanotubes, graphene, topological insulators, nanostructured superconductors, and other novel 1D or 2D systems."



Physics Tree

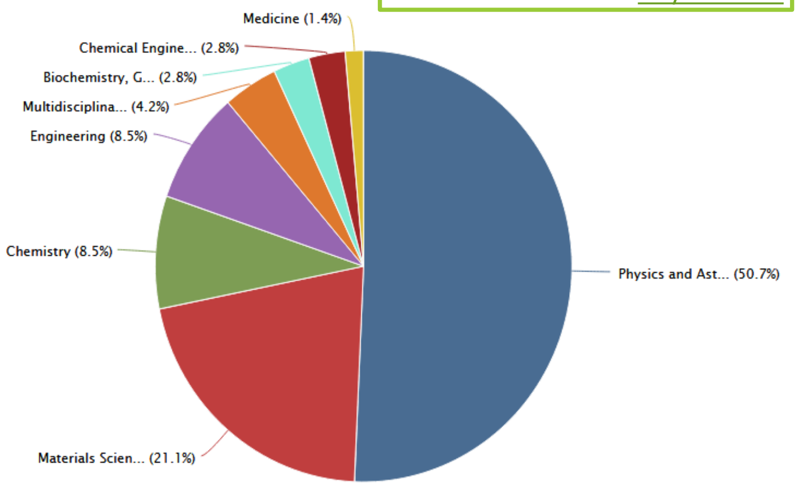
Mason, Nadya Back to author details page
University of Illinois at Urbana-Champaign, Department of Physics and Materials Research Laboratory, Urbana, United States
Author ID:7101772145

Documents (42) | *h*-index (22) | Citations (1524) | Co-authors (150)

by source | by type | by year | **by subject area**

Subject Area	Documents
Physics and Astronomy	36
Materials Science	15
Chemistry	6
Engineering	6
Multidisciplinary	3
Biochemistry, Genetics and Molec...	2
Chemical Engineering	2
Medicine	1
Total	71

Documents by subject area



Selected Publication Sites: Applied Physics Letters, Nano Letters, Nature Physics, Physica B: Condensed Matter, Physical Review B - Condensed Matter and Materials Physics, Science

Research Community Analysis by Discourse

- *scientific narrator*
- *(**implied**) audience of peers (two levels: reviewers / editors, readers / listeners)*
- *contextualized in subspecialized community investigating similar problems / phenomena*

Engineering controlled terms:	Graphene, Lead, Scanning Tunneling Microscopy, Spectroscopy
Engineering main heading:	Probes

Abstract

“We show that evaporating lead (Pb) directly on graphene can create high-yield, high-quality tunnel probes, and we demonstrate high magnetic field/low temperature spectroscopy using these probes. Comparisons of Pb, Al, and Ti/Au probes show that after oxidation a well-formed self-limited tunnel barrier is created only between the Pb and the graphene. Tunneling spectroscopy using the Pb probes manifests energy-dependent features such as scattering resonances and localization behavior and can thus be used to probe the microscopic electronics of graphene.”

Tunneling spectroscopy of graphene using planar Pb probes

Appl. Phys. Lett. 102, 023102 (2013); https://doi.org/10.1063/1.4775600

Yanjing Li and Nadya Mason

Research Community Analysis by Discourse

discourse: written or spoken communication (Latin *discursus*: running to and from)

discourse community: a group of people with a shared purpose who use communication to achieve their goals. This community has established mechanisms for intercommunication and feedback (publications, meetings, online forums), communication genres (research papers, conference presentations, posters), and a “threshold level” of members with expertise in both content and discourse (John Swales).

Professional discourse communities cohere around forums for information exchange (such as a peer-reviewed journal). Their shared goals, values, beliefs, practices, etc. (culture) are

embedded tacitly in how and what members communicate *(topics, approaches, genres, macro-patterns, specialized language)*

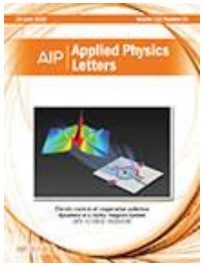
e.g.: genre: research paper (next slide: sub-genre: experimental report), discursive macro-patterns: topic (next slide: method > rationale > application > interpretation > illustration)

and signaled explicitly in how they maintain community, signal membership, and indicate contributions *(associations, awards, editorial boards, editorial advisory boards, peer reviewers / readers, publication, institutional affiliations of authors, references, acknowledgements).*

e.g.: references (named methods/techniques/phenomena, intertextual citation in body and/or endnotes, literature review scope, references cited list)

e.g.: acknowledgements (funding, formal and informal intellectual contributions)

“This work was supported by the **NSF DMR**-0906521. We thank **M. J. Gilbert** for useful discussions. This work was partly carried out in the **Materials Research Laboratory Central Facilities** (partially supported by the **DOE** under DE-FG02-07ER46453 and DE-FG02-07ER46471).”



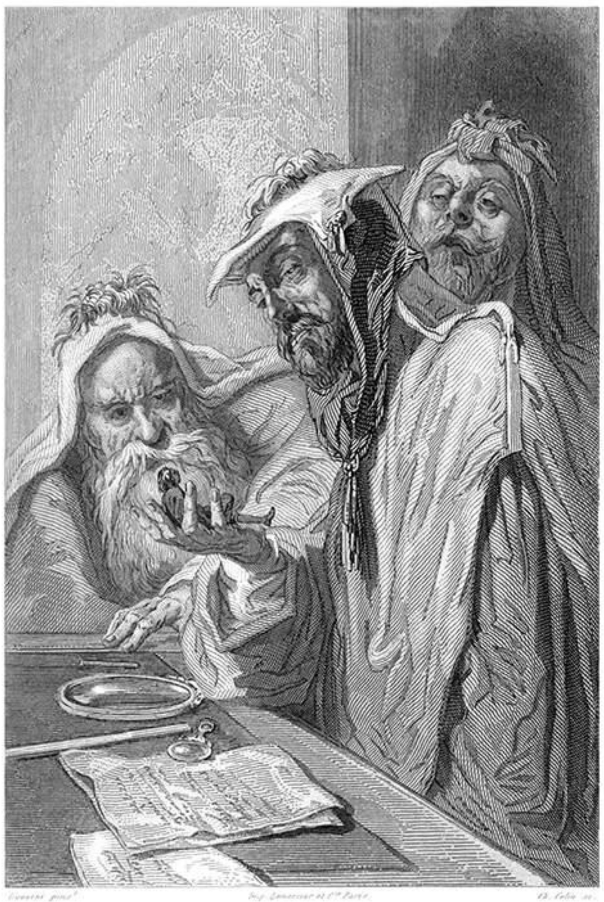
"*Applied Physics Letters* (APL) features concise, **up-to-date** reports on significant **new** findings in applied physics. Emphasizing **rapid** dissemination of key data and **new** physical insights, APL offers **prompt** publication of **new** experimental and theoretical papers reporting applications of physics phenomena to all branches of science, engineering, and **modern** technology." *current ("new," novel, now) and …*

"The high quality of the Pb probes can be determined via transport measurements. **[< method]** It is particularly useful to measure below the Pb superconducting transition temperature of 7.2 K, as the low voltage-bias conductance is then dominated by the characteristic Bardeen-Cooper-Schrieffer shape of the density of states. **[< rationale]** In this case, there are no single-particle states for an energy scale of ±Δ (the superconducting gap energy), and sharp peaks appear in the differential conductance at the gap edges. This gap feature in conductance is a typical characteristic of superconductor-normal tunneling,[18] and the quality of the tunnel barrier can be determined by the quality of the gap. **[< application]** In particular, no conductance observed around zero bias implies that the tunnel barrier is not leaky. A lack of conduction inside the gap also implies that the tunnel barrier is fully insulating, as an overly conducting tunnel barrier would allow quasiparticle transfer inside the superconducting gap[19] (via a process known as the Andreev reflection). **[< interpretation]** Figure 2 shows differential conductance vs. tunnel voltage bias for Pb-graphene junctions at 250 mK. Most Pb probes that reached a minimum resistance of several hundred kΩ showed similar behavior" **[< illustration]**.

Illustration of discursive macro-patterns

Research Community Analysis of Scientific Narrator and Audience

*scientific narrator as a **peer among peers**—embodying the same disciplinary / communal / discursive practices and norms as the implied and actual audiences*



- operates within a learned, specialized community (accountable, intertextual, indexed) and communicates in conventional ways (uses IMRAD organization, multimodal rhetoric, house style)
- discusses topics of shared interest using established methods / techniques and forms of evidence that are credible within that community
- **emphasizes what is done, observed, found** *rather than* the doer, observer, finder (group "we," passive voice, research topics as subjects)
- projects sense of **objectivity and inquiry** over preconception and assumption (skeptical, self-critical)
- articulates **reason and logic** over emotion and expression (neutral, distant, analytical)
- reports with care for **accuracy**, particularly with methods, measurements, and causal relationships
- establishes claims with **evidence and rationale for evidence** as valid support
- approaches **full transparency and accessibility** (of data, method) if not complete reproducibility
- "hedges," with **degrees of certainty** (Hyland, 1998)

II. Communicating with Non-Experts

Science Communication (journalism / mass media and outreach)

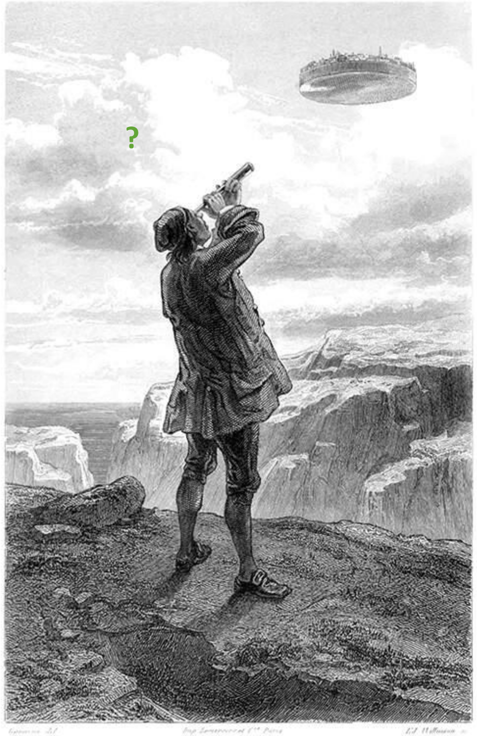
communicating about science to the public

Professional Communication (administrative)

communicating within organizations on issues that may or may not relate to technical matters

For Individual Communicators, Most Audience Analysis is Guesswork

Research into audience factors can be quantitative (social media analytics, surveys) and qualitative (focus groups, interviews).



Demographic *age, income, gender, race, occupation, etc.*

↑↓ *assumptions, biases, stereotypes*

Psychographic *activities, interests, and opinions [AIO = lifestyle / culture]; attitudes; values; behaviors*

Most of the time, for individual communicators, audience analysis is informal and experiential. Before you plan and engage, do as much research on and thinking about the audience as you can.

Making an Educated Guess

Investigate: Who is Your Audience? What is their probable…

Motivation: Voluntary or Captive? Use or Interest / Curiosity?

- *Voluntary audiences are more engaged than captive ones. What can you do to engage captive audiences?*
- *Given a potentially curious, voluntary audience, what can you do to interest them without sensationalizing or fearmongering?*
- *Some audiences are interested in using what they learn. How does an audience that intends to use what they learn provide special challenges?*

Attitude: Current Events? Related Controversy? Hopes / Fears?

- *Assume your audience has a positive attitude toward science and scientists (this is generally true in the United States).*
- *General audiences may come to your material already influenced by current events or controversies. Your material may touch upon their existing hopes and fears. How can you anticipate and address these?*

Knowledge: Background? Education? Interests?

- *In addressing any general audience, you can't go wrong by using plain English, defining specialized terms, providing media aids, and using analogies and/or telling stories.*
- *Many non-scientists have special interests that incorporate some amount of scientific knowledge (gardening, dog training, early childhood, advanced cooking). How can you tap into these?*

U.S. Public
on Science and Engineering

GENERAL KNOWLEDGE

FACTS **Factual knowledge "strongly related to individual's level of formal schooling."**

NSF 2016 Survey / Bachelor's: 74%; HS: 57%; HS Dropout: 43% correct

NSF 2016 Survey / 9 ≥ STEM courses: 80%; 5 ≤ STEM courses: 55% correct[b]

"Public understanding of science has increased over time and by generation, even after controlling for formal education levels."

In 2016, the top-performing age group was 25-34 year olds. White (non-Hispanic) respondents performed better than Black and Hispanic respondents at all education levels, which may indicate "systemic differences…in the quality of the education that different groups are receiving." Men performed an average of 12% better than women in a 2015 Pew survey.[b]

CONCEPTS In understanding scientific inquiry (i.e., probability, experiment, and the nature of scientific study), **Americans averaged 43%** in correct answers to questions in the 2016 NSF survey.

"In general, men, respondents with more education, and respondents with higher incomes did better," as did those in the middle-age range.[b]

GENERAL ATTITUDES

67% believe science has a "mostly positive" effect on society[a] and 72% believe that the "benefits of scientific research strongly/slightly outweigh harmful results.[b]

84% support federal spending on scientific research "to advance the frontiers of knowledge" by the federal government "even if it brings no immediate benefits"[b]

A majority tends to trust scientists more than other groups (e.g., insiders, news media, elected officials) for information on research-relevant controversies.[a]

Public confidence in scientific leadership tends to run around 40% "great deal of confidence" and 50% "only some confidence." Men express more confidence than women, young more than old, and those with more education and higher income more than those with less.[b]

Public confidence on whether scientists' findings are consistently influenced by the "best available evidence" tends to weaken on controversial issues (e.g., climate change, GM food).[a] Increasingly concerned about pollution and new technologies.[b]

[a]Pew Research Center, "U.S. Public Trust in Science and Scientists," June 2017 [b]National Science Board Science & Engineering Indicators 2018

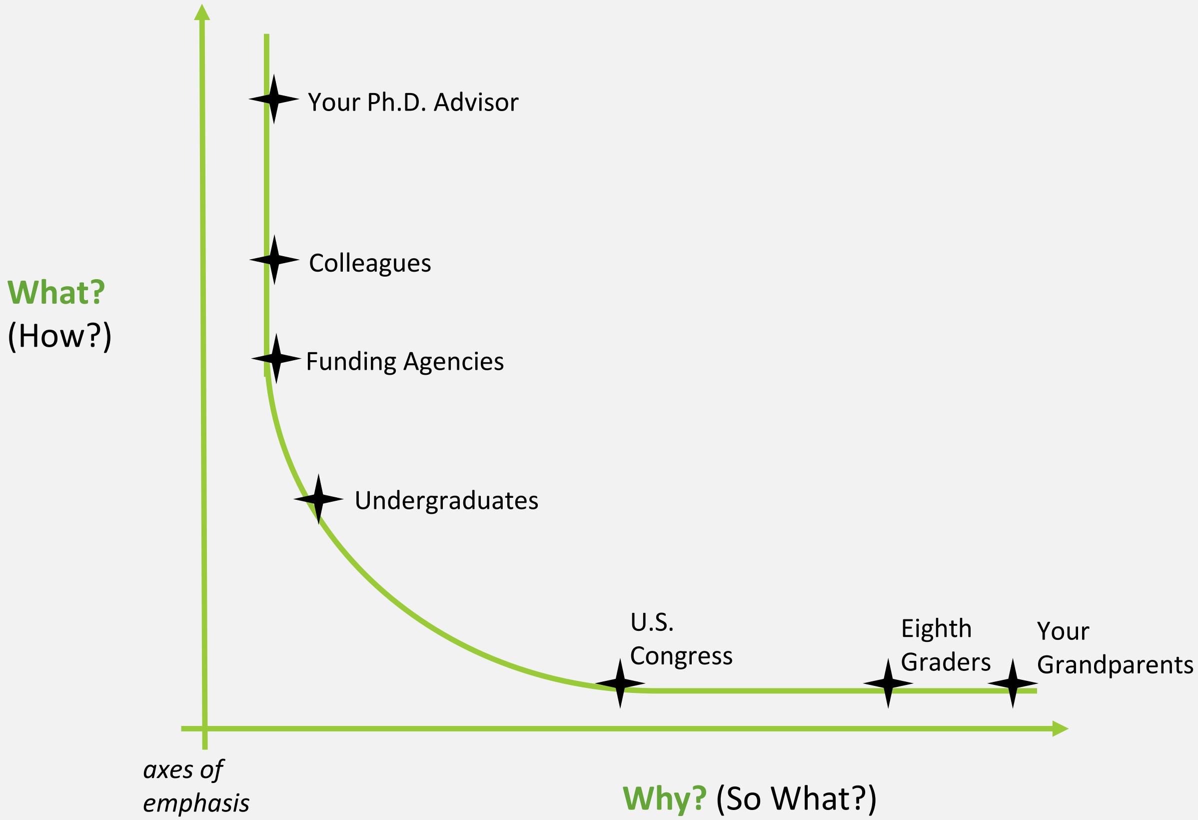
M-A-K-E Your Audience Care

For outreach and engagement to succeed, a science communicator must assess:

- **audience motivation** — *How is the science message relevant or meaningful to the audience?*
- **audience attitude** — *How does the science message fit into the audience's current awareness and worldview?*
- **audience knowledge-level** — *What about the science message is already known by the audience? What does the audience need to know to understand the science message and why it matters?*
- **audience expectations and preferences** — *How does the audience expect the science message to be delivered? How would the audience prefer that it be delivered?*

See handout: "All about Graphene," Physics.org

Emphasizing the What or the Why by Audience Type *(knowledge communities)*



Emphasizing

*What did you do? How did you do it? [**craft of research**]*

- *research rationale*
- *research question(s)*
- *methodology*

vs.

*Why spend time and money on this? Why should we care? [**big picture**]*

- *How does your research advance what scientists (in your field) know and can do? (NSF: **intellectual merit**)*
- *How will your research help us as a society? (NSF: **broader impacts**)*

Translating Science for the General Public

*Which is the abstract for an **expert** audience? Which is for **non-experts**? How can you tell?*

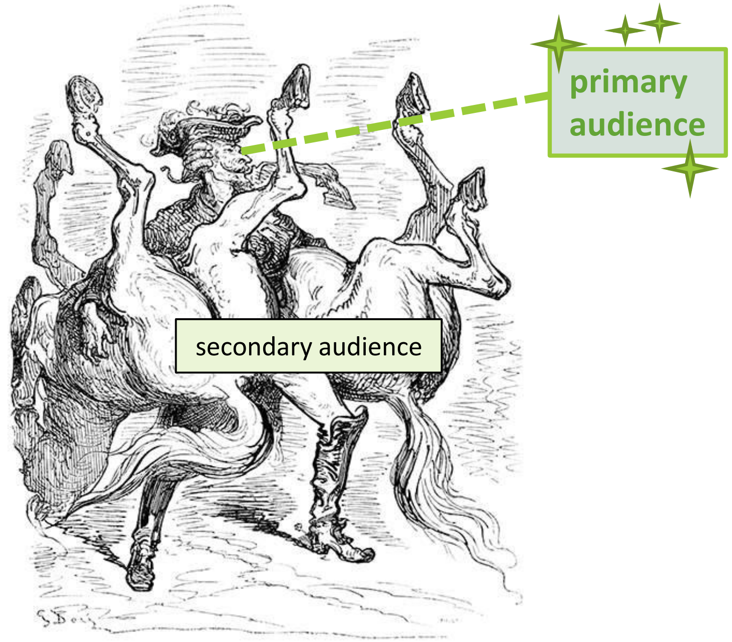
The goal of this project is to observe and characterize the properties of correlated electron pairs at nanoscale interfaces between superconductors and strongly-correlated materials. Coherent electron pairs emerging from superconducting sources will be studied in materials such as nanotubes, graphene, and ferromagnetic wires. In addition, methods for splitting injected Cooper pairs and then non-locally preserving quantum correlations will be developed, with the ultimate goal of realizing solid-state quantum entanglers. Experimental measurements of transport, phase coherence, and noise correlations will be supported by theoretical studies. The research will address major issues such as the influence of competing ordered states, the proximity effect at superconductor-correlated state interfaces, quantum phenomena in reduced dimensions, and optimal configurations for entanglement tests. This work will enable significant progress in our understanding of strongly-correlated nanoscale systems, and may form the basis of future solid-state quantum cryptography, teleportation, and quantum computation devices. The collaborative structure of the research will provide a rich environment for training undergraduates, graduate students, and postdoctoral researchers in a broad spectrum of nanotechnology-related work. Educational aspects will be further integrated through the development of courses directly related to the proposed research and through research-related seminars and meetings that target high-school teachers, women, and underrepresented minorities.

The ability to control the flow of electrons through materials has been the key to technological progress in our society. Common electronic technology is based primarily on the “classical” motion of electrons through metals or semiconductors. However, the next revolution in electronics will likely be based on the “quantum mechanical” properties of electrons, such as their wave-like behavior and inherent “spin.” These properties may form the basis of advanced cryptography and ultra-powerful “quantum” computers. The goal of this research is to study and control such quantum electronics in nano-scale materials such as carbon nanotubes, superconducting wires, and magnetic wires. These materials are relevant because of their potential applications; they are also interesting because of the diverse phenomena stemming from their strongly interacting electrons. The research will target physics at the nano-scale, which is the next frontier for technology and where quantum properties are prevalent. A series of experiments supported by theories will work toward implementation of advanced quantum electronic devices and address fundamental, open questions regarding the behavior of electrons in nano-scale materials. The collaborative structure of the research will provide a rich environment for training undergraduates, graduate students, and postdoctoral researchers in a broad spectrum of nanotechnology and materials-related work. Educational aspects will be further integrated through the development of courses directly related to the proposed research and through research-related seminars and meetings that target high-school teachers, women, and underrepresented minorities.

III. Mixed & Hybrid Audiences

Expert
- Administrators + Subject Matter Experts (SMEs)
- Advanced Researchers + Students
- Evaluator + Practitioners
- Hybrid: Same Phenomena or Problem but Interdisciplinary
- Hybrid: English Speakers but Native + Non-Native

Non-Expert
- Organizers + Invited Audience
- Adults + Children
- Hybrid: Scientifically Literate but Varying Levels



mixed: identify and address primary audience
hybrid: identify common ground, compare /contrast perspectives

Thank you!

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Illustrations: Gustave Doré, *Wunderbare Reisen…von Munchhausen*, and Paul Gavarni, *Voyages de Gulliver*