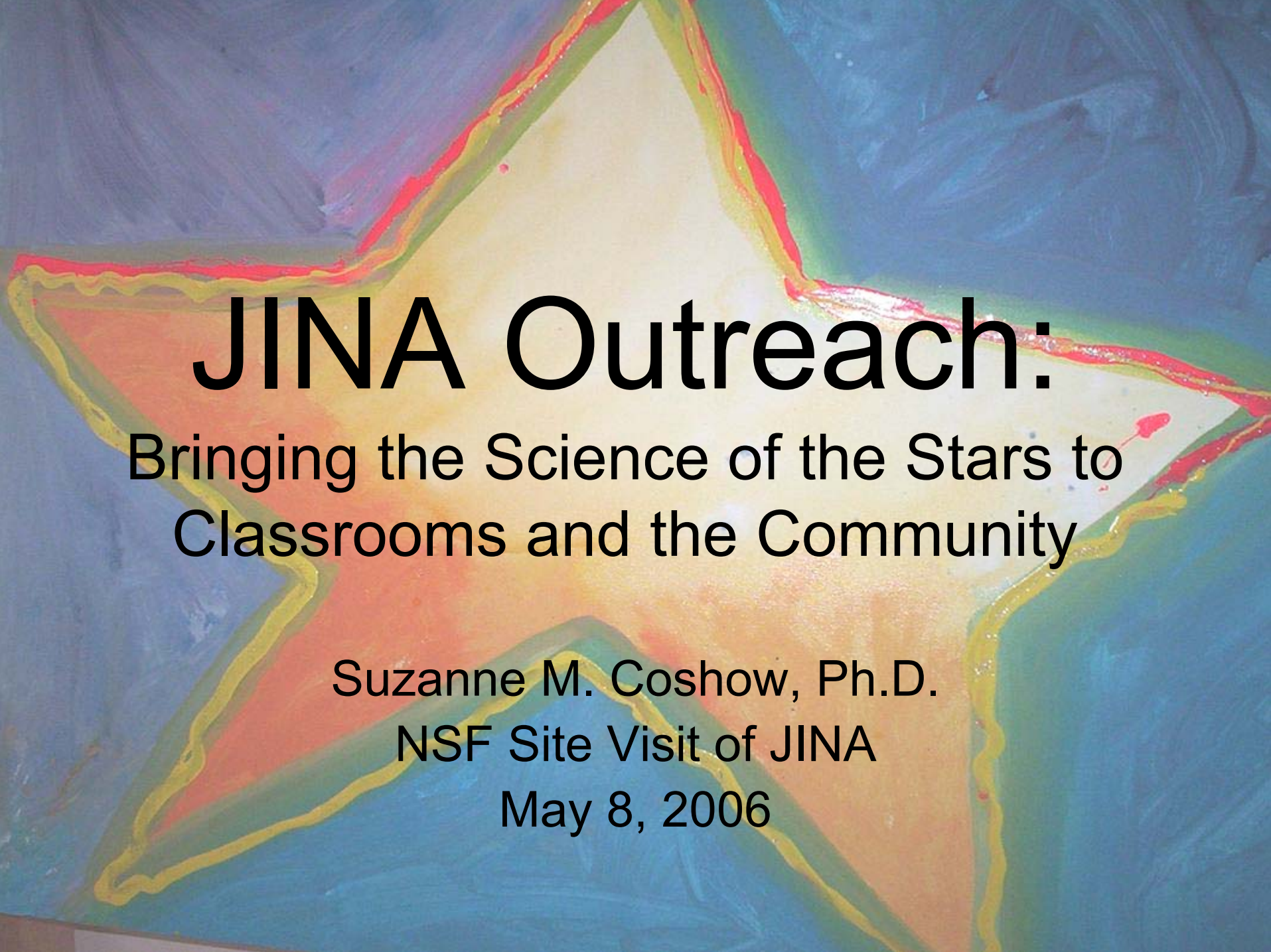


JINA Outreach:

Bringing the Science of the Stars to Classrooms and the Community

Suzanne M. Coshow, Ph.D.

NSF Site Visit of JINA

May 8, 2006

What is Outreach?

Merrian-Webster Dictionary Definition:

The extending of services or assistance beyond current or usual limits <an outreach program>.

JINA Outreach Mission & Vision

- **The JINA outreach program is focused on connecting the science of JINA with all audiences - from the academy to secondary school students to the public - providing opportunities for meaningful collaboration whenever possible.**
- **Our outreach goals include contributing to K-12 science education, reaching the public primarily through the internet, and increasing diversity in science.**

Audience	Effort
Community & Knowledge Transfer	Visitor program, Schools, Conferences & Meetings; Virtual Journals (JINA VJ; SEGUE VJ) Data Libraries (RRL & EAD)
Graduate Education & Training	Schools (intensive technical training); Workshops/Conferences; New Curriculum
Undergraduate Education & Training	Research Experience & Mentoring (JURA); New Curriculum
K-12 Outreach	Research Experience/Enrichment; Curriculum Enhancement (Materials); Development of New Content
Public Outreach	Development of New Content Public Events Museum Partnerships

Organization of Outreach Effort

- Core Program
  - JINA Sponsored

    e.g., PAN, PIXE-PAN, CMG & Art to Science
- Opportunity Program
  - JINA Supported or Involved

    e.g., Sensing Our World, CISCI, PFCEON
- Exploratory Program
  - Combination of Sponsored and Supported

    e.g., Products (Posters, Movies & Games), Public Programs, Museum Partnerships, etc.

Commitment to Diversity

JINA has developed multi-pronged approach to diversity involving a commitment to reach out to the appropriate communities at all levels: from the hiring of faculty and researcher hiring to research collaborations to student exchanges and future recruitment.

- Specific Activities & Programs:
  - Scientist and Booth Representation at Professional Meetings
  - Graduate Research Fellowships
  - REU Student Exchange with Hampton University
  - Space Explorers - recruitment from inner-city Chicago
  - Art to Science for Special Needs Students
- Good Indicators:
  - 29% of participants at JINA Schools are Women!
  - Diverse participation in K-12 outreach programs (e.g., art to science this year reached schools with 51% minority students on average)

Scientist Involvement & Oversight

The nature of the JINA outreach program requires significant involvement by the scientists, post-docs and students, perhaps more so than many other outreach programs.

- Mentoring (e.g., JURA, REU, Schools)
- Summer Programs
- Product Development (from design to oversight)
- Public Lectures and Events
- Museum Collaborations

Scientist Involvement & Oversight

Outreach Advisory Committee

Paul de Young (Hope College)
Umesh Garg (ND)
Jerry Hinnefeld (IUSB)
Kevin Johnston (Jimtown High School)
Peggy McMahan (LBNL)
Michael Thoenessen (MSU)
Phil Sakimoto (ND)

Context & Challenges of JINA Outreach

- The state of education in the US provides many challenges to our desire to bring this very advanced science into K-12 classrooms.
  - Need to recognize and work within their curricula;
  - Need to balance our goal of reaching diverse audiences with the realities of K-12 schools
- The multi-institutional nature of JINA requires attending to very different local institutional needs and resources, as well as requiring programs which are geographically neutral and therefore JINA-wide.

E/PO Meetings

- ADMIRE November 2003
  - "Teacher Impacts of the RET Program: Survey Results from Six Sites"
- ADMIRE April 2004
  - "Teacher Impacts of the RET Program: Survey Results from Six Sites" with workshop on revising the survey instruments
- Aspen Center for Physics E&O Workshop 2004
- NRCEN 2005 - workshop with Fiona Goodchild (UCSB)
  - "What is Outreach and How do you evaluate it?", "From the University Lab to High School Classroom: Lessons from the RET Program 2004"
- NRCEN 2005 – 2 (follow-up workshop to develop white paper)
- Astronomical Society of the Pacific E/PO 2005
  - Poster: From ART to SCIENCE: Igniting Stellar Imaginations
- NSTA 2006 – national science teacher association

Outreach by Type

- **Educational Training**
  - JINA Schools & Workshops
  - New Curriculum (e.g., Hendrik's graduate course)
- **Research Experience**
  - JURA @ MSU & ND; REU@LANL
  - PAN@MSU; PIXE-PAN@ND; Sensing Our World
- **Curriculum Enhancement & Development**
  - MiniGrants; Art to Science; web movies/interactives
  - The JINA poster and CNO cycle card game
- **Products & Events**
  - Extensive web pages (games & posters)
  - Film and lecture series

Outreach by Audience: College & University

- Graduate:
  - Pre-Dissertation Fellowship
    - (summer or semester to develop thesis project)
  - Dissertation Fellowships
    - (2 years to complete thesis research with JINA)
- Undergraduate:
  - JURA@ MSU & JURA@ND
  - REU@ LANL & ANL
  - REU through existing programs at the universities

Outreach by Audience: K-12

- **High School**
  - PAN@MSU; PIXE-PAN@ND summer programs
  - HS Student Research Experience Programs (MSU & ND)
  - Classroom Materials Mini-Grants
- **Middle School**
  - Sensing Our World
  - Classroom Materials Mini-Grants
- **Elementary School**
  - From ART to SCIENCE: Igniting Stellar Imaginations
  - Classroom Materials Mini-Grants

Bringing the Classroom to the Laboratory: **JINA's Research Experience Programs**

Physics of Atomic Nuclei (PAN) @ MSU (7/24 – 8/4)

A 2-week program at the NSCL, PAN brings in middle and high school teachers and high school students to do cosmic ray experiments and learn about nuclear physics. Teachers build the detectors the first week and students join them the second week, designing and doing an experiment. Program is residential for both teachers and students.

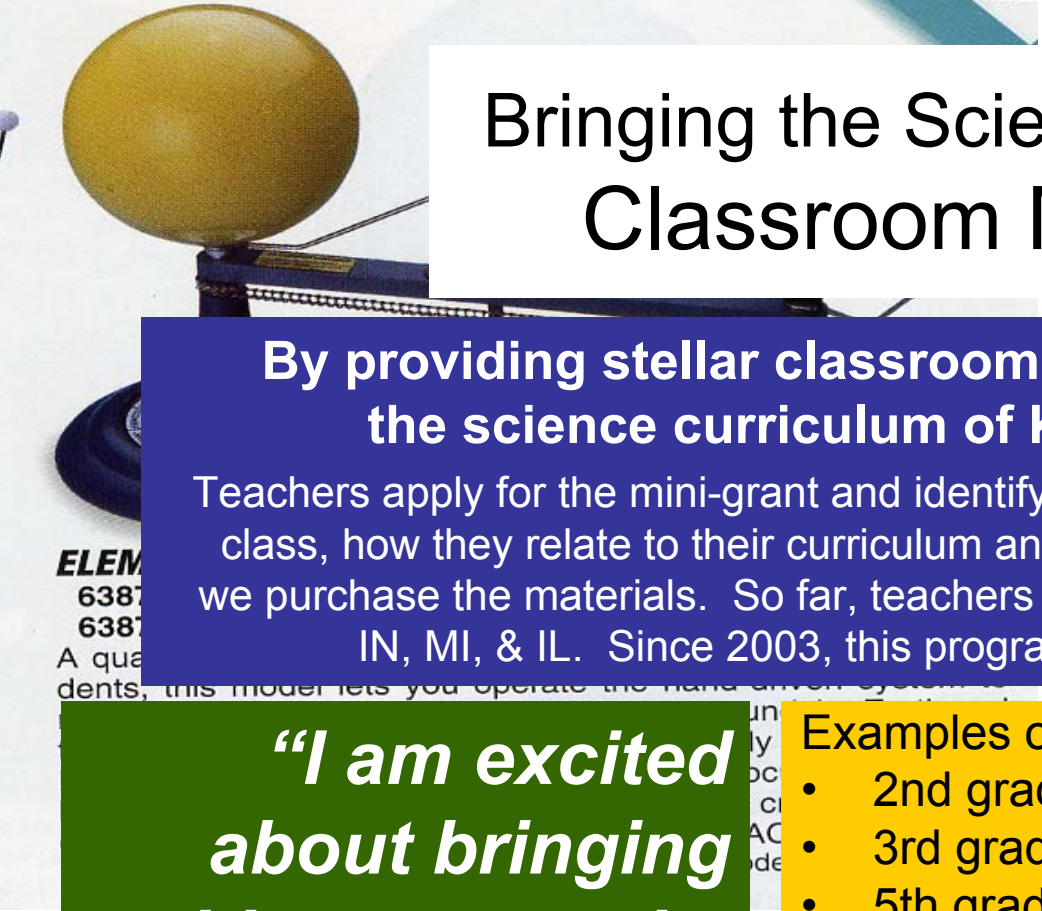
PIXE-PAN @ ND (June 12 – 23)

JINA will replicate MSU's PAN program at ND in 2006, but with a PIXE focus, rather than cosmic rays. High school teachers will work with NSL faculty to set up a PIXE (proton induced x-ray emissions) experiment to analyze historical artifacts, learning accelerator and nuclear physics techniques. High school students will join them the second week to carry out analyses. Program is residential for teachers. Local high school students needed!

Sensing Our World @ ND (6/26-30)

A week long physics day-camp for middle school students at ND in 2006. Students learn physics and chemistry through hands-on activities. Pictured here, SOW 2005 participants learning physics.

JINA



Bringing the Science into the Classroom: Classroom Materials MiniGrants

By providing stellar classroom materials, we seek to enhance the science curriculum of K-12 classrooms at every level.

Teachers apply for the mini-grant and identify the materials they want to enhance their class, how they relate to their curriculum and to the field of nuclear astrophysics, and we purchase the materials. So far, teachers from K to 12th grade have participated in IN, MI, & IL. Since 2003, this program has reached over 3000 K-12 students!

"I am excited about bringing this opportunity to "do science" to our 7th grade students!"

Kesling Middle School, Laporte, Indiana

Examples of materials purchased, by grade:

- 2nd grade - trade books, games
- 3rd grade - videos, books, posters
- 5th grade - solar system simulator
- 7th grade - vacuum, spectroscope, prism,
- 8th grade - roller coaster physics set (WYP)
- High School - radiation sources, LCD projector, particle physics software, classroom sets of spectrometers

World Year of Physics 2005

For the 2005 World Year of Physics (WYP), we expanded the subject matter to include any WYP activity or project.

JINA

From ART to SCIENCE:
Igniting Stellar Imaginations

This project is funded by the NSF through grant PHY0216783, and the universities of JINA.

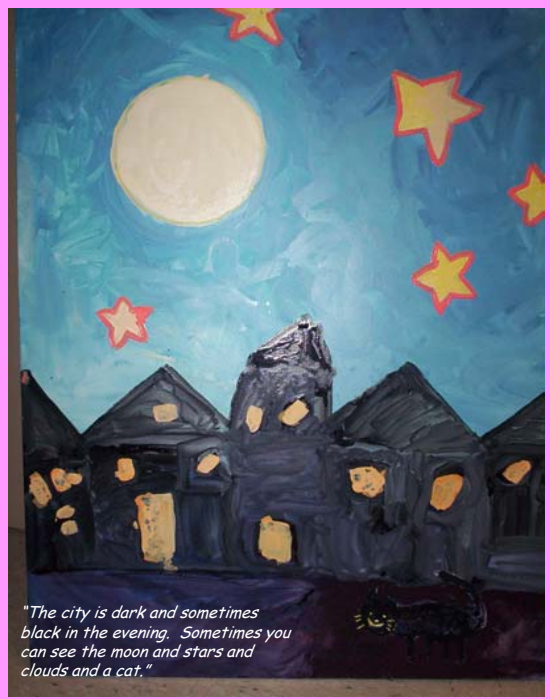
A 5 year old in head start in St. Louis working on "Dark City with Black Cat"

To reach young children, JINA has created an outreach project combining ART and SCIENCE. With this project we ignite the stellar imaginations of children and interest them in the wonders of the stars. JINA provides books to point children toward the stars and purchases the art supplies. Children then create art, which we exhibit and publish. Since 2003, this program has reached over 1,000 kids in three states.

"Splatter Stars"
by Catherine Shields & Alexis Murillo

Kennedy Primary Academy
South Bend, Indiana

(16x20" canvas on exhibit in the NSCL lobby at MSU)



"The city is dark and sometimes black in the evening. Sometimes you can see the moon and stars and clouds and a cat."

"Dark City with Black Cat"

Kenyon (5), Tokesha (5) & Lexis (5)
YOUTH IN NEED, St. Louis, MO

"The Stars of Bennett Woods"

Ms. Alligood's 3rd Grade Class at Bennett Woods Elementary, Okemos, Michigan

(6'x5' canvas painting on exhibit in the lobby of the NSCL @ MSU)

JINA

Outreach by Audience: Public

Cinema & Science Project

- physics & film series @ ND
- MSU & Undergraduate involvement

GEO-WALL (with KICP)

- 3D visualization technology using SDSS data

Web-Based movies, games & interactives

- 10 part series in Nuclear Astrophysics, movies

New Products

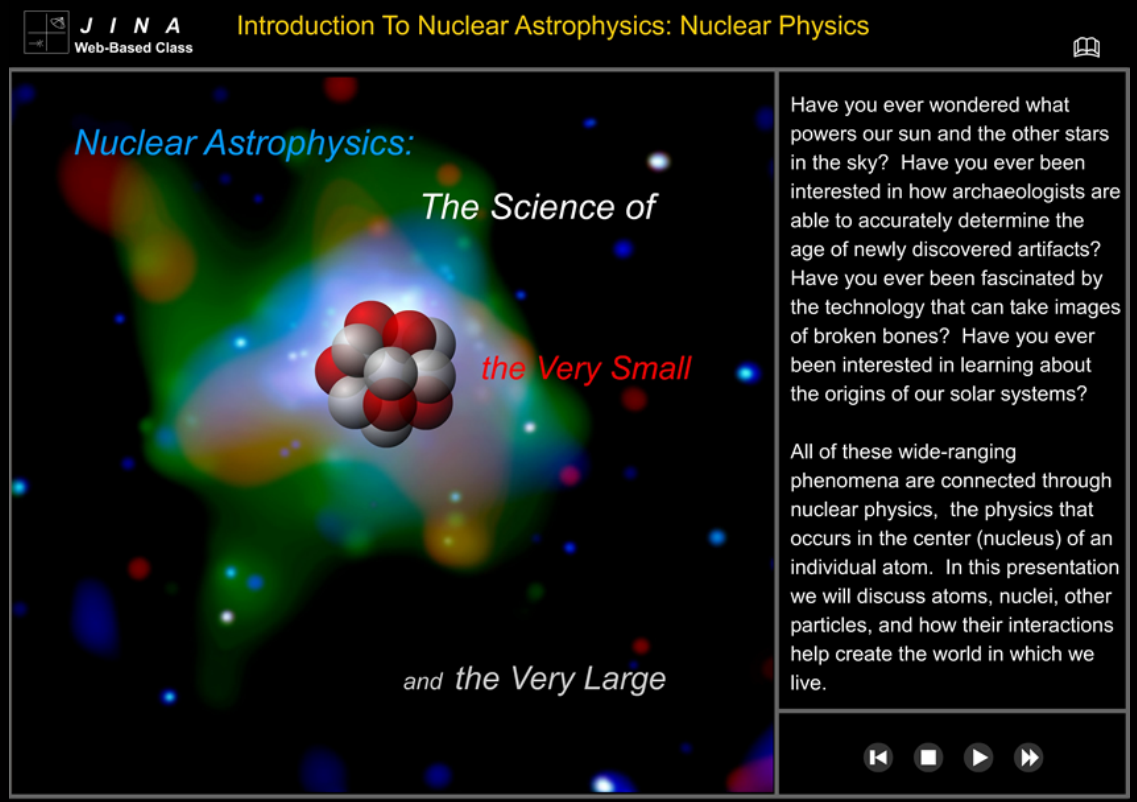
- The Art of Nuclear Astrophysics Scientific Poster
- CNO Cycle Card Game

Museum Partnerships & Collaboartions

- Impressions 5 (I5) Museum in Lansing
- Exploratorium (JINA and PFCEON)

JINA GAMES:

On-Line Interactives in Nuclear Astrophysics



The ten part series will begin with three primers – introductions to astronomy, astrophysics and nuclear physics and then move through the subject matter, ending with the future of nuclear astrophysics.

First there is a narrative, then a ‘drag and drop’ section where players create reactions, and last there is a quiz.

Three Games are already on line!

Observe what our eyes can't see

Observation

γ-ray image of ^{26}Al radioactivity in the Galaxy

In space, satellites are equipped with X- or gamma(γ)-ray detectors, such as Chandra…or INTEGRAL…

X-ray image of pulsar wind around a neutron star

A neutron star?

A black hole ?

What is left after a supernova explosion ?

Reactions making heavy nuclei need extreme environments as in the explosion at the death of a star-- a supernova

How are elements heavier than iron made ?

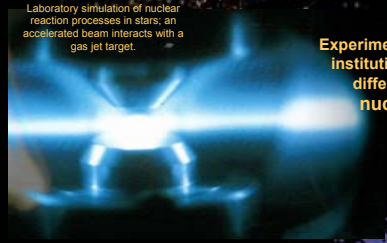
Future research in this field will be greatly enhanced by the building of a next generation accelerator facility such as the Rare Isotope Accelerator (RIA), enabling deeper insights into exotic nuclei and stellar processes.

The Art of Nuclear Astrophysics

J I N A

Simulate in the laboratory the processes in the center of stars and in stellar explosions

Experiment

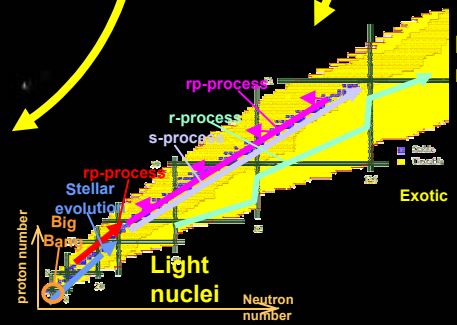


Laboratory simulation of nuclear reaction processes in stars: an accelerated beam interacts with a gas jet target.

Experiments are done at JINA institutions to simulate the different reactions of nucleosynthesis

Cocktail Beam

Exotic beams can be made by by breaking up fast heavy nuclei. Mixed, cocktail, beams let us study many reactions at once.



Heavy nuclei

Beams of exotic radioactive nuclei let us mimic the nuclear reactions in stars. JINA researchers study reaction rates and structure of the same exotic nuclei that participate in nucleosynthesis processes,

Understand the underlying physics of what is observed

Theory

How are these γ-rays produced ?

How are the heavy elements in the universe made ?

Element formation in stars

Stars shine and their light comes from the energy of nuclear reactions that produce Helium, but also heavy elements such as Oxygen, Neon and Silicon, up to Iron

What nuclear reactions make them ?

Why were only light elements produced by the Big Bang nucleosythesis ?

The expansion of the universe caused a rapid decrease in density such that no nuclear reactions could take place to form heavy nuclei

Energy of the Big Bang produced matter

WMAP

The Big Bang's remnant, the cosmic microwave background radiation, is detected by special observatories

They use, for example, the SOAR telescope

JINA astronomers study the heavy elements that are found in many astrophysical environments including the oldest stars ever observed.

Supernovae and x-ray bursts are studied with theoretical models to find the important nuclear processes that could explain the observations

Artist's view of an accreting neutron star producing X-ray bursts

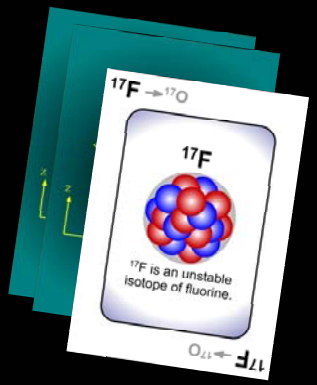
Once upon a time…

The Joint Institute for Nuclear Astrophysics

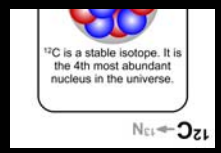
www.JINAweb.org

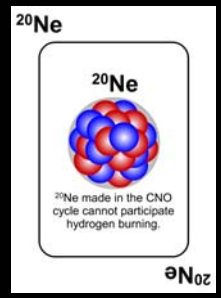
Photo Information [Credits]: WMAP [NASA]. Whirlpool Galaxy: Hubble Telescope picture [NASA/STScI/AURA]. SOAR Telescope: the Southern Astrophysical Research (SOAR) Telescope, searching for elemental abundances in stars [LNA/CNPq/NOAO/UNC/MSU]. Giant galactic nebula NGC 3603 [W. Brandner (JPL/IPAC); E.K. Grebel (U.Washington); Y.H.Chu (U.Illinois); NASA]. Gas Jet Target [M.Wiescher (U.Notre Dame)]. Supernova remnant 0540-69.3 [NASA/CXC/SAO]. Neutron Star: a neutron star in the Crab Nebula [NASA/CXC/ASU/J.Mester et. al.]. Chandra: Artist's illustration of the Chandra Spacecraft [CXC/NGST]. INTEGRAL: Artist's illustration of INTEGRAL Spacecraft [ESA; Illustration by D. Ducros.] Gamma-ray image of radioactive 26 Al [SPI team at INTEGRAL]. X-ray binaries in Globular Cluster NGC6266 [NASA/CXC/MIT/D.Pooley et. al.] Simulation: core collapse simulation from a 15 solar mass progenitor - the solid data shows the cobalt distribution: the decay of the radioactive cobalt produces the gamma rays detected in the observations [SciDAC Supernova Science Center (UCSC)]. JINA is funded through NSF Grant PHY0216783, and the universities of JINA.

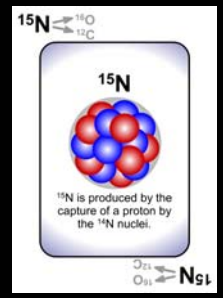
CNO CYCLE
CARD GAME



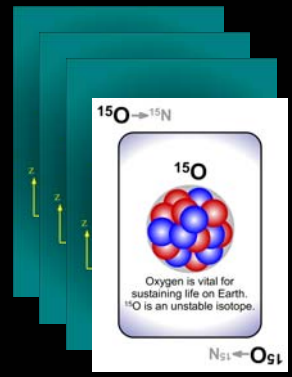
HAND







PLAY ROW



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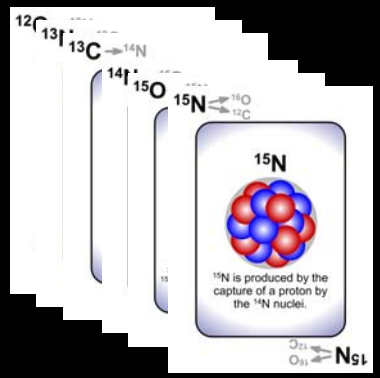
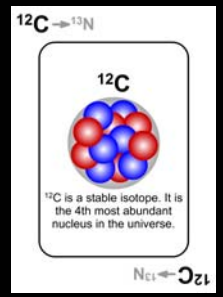
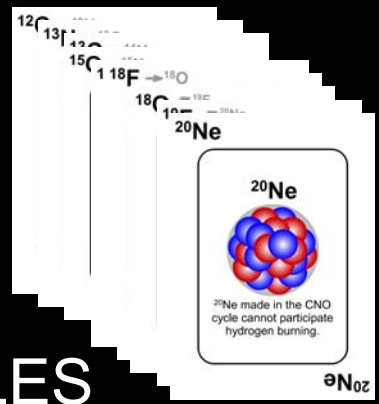


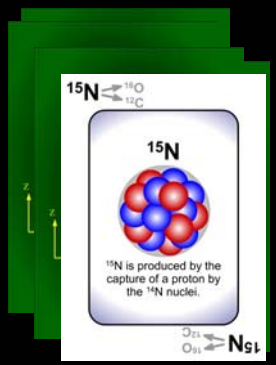


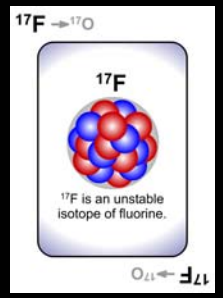


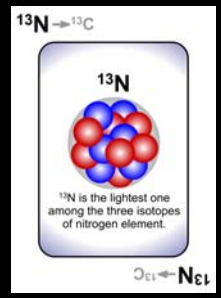
REACTION PILES

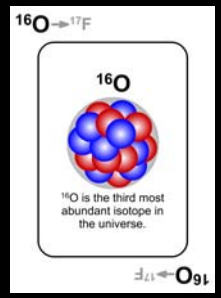
HAND

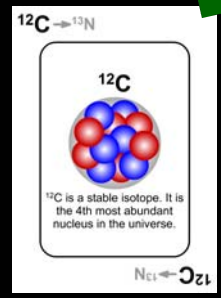
STOCK











PLAY ROW

Outreach Research:
Evaluating the Impact of E/PO Programs

60%

- Internal Evaluation of JINA education & outreach
  - Developing surveys to assess the impact the classroom materials
  - Developing a comparative case study to assess art to science
  - Exit Surveys from all JINA schools
  - Baseline study regarding domed teaching environment
- Evaluating RET/REU -
  - Analysis of self-reported surveys for ~10 RET sites
  - REU evaluation for 3+ sites (Stanford, ND, IBM/SJSU)
- Explaining the Need for Educational Outreach

The Reach of JINA Outreach: Program Partners

LOCAL:

- Center for Sensor Materials @ MSU (until 2005)
- South Chicago Art Center
- University of Chicago Web Docent Program
- St. Joseph County Parks Department
- ETHOS and NISMEC (Teacher Science Institutes)

BEYOND LOCAL:

- KICP
- PFCEON
- CISCI – EU Cinema & Science Partnership

The Reach of JINA Outreach: Evaluation/Assessment Partners

LOCAL:

- Notre Dame's REU
- Quarknet's RET
- RET@ND – math, engeneering, chemistry, biology

BEYOND LOCAL:

- ADMIRE RET nationwide
  - » UCSB, Stanford, Columbia, Colorado, Penn, etc.
- IBM/SJSU REU
- Stanford University (both REU and RET)
- Harvard Smithsonian Center for Astrophysics
- Penn State – Evaluation of Web-Based Materials

Successes
JINA's Research Experience Programs

These two week programs provide hands-on involvement with the research and techniques of JINA to middle and high school teachers and high school students. An alternative to the standard RET program, these residential programs can reach teachers from across the US.

Physics of Atomic Nuclei (PAN) @ MSU (7/24 – 8/4)

A 2-week program at the NSCL, PAN brings in middle and high school teachers and high school students to do cosmic ray experiments and learn about nuclear physics. Teachers build the detectors the first week and students join them the second week, designing and doing an experiment. Program is residential for both teachers and students.

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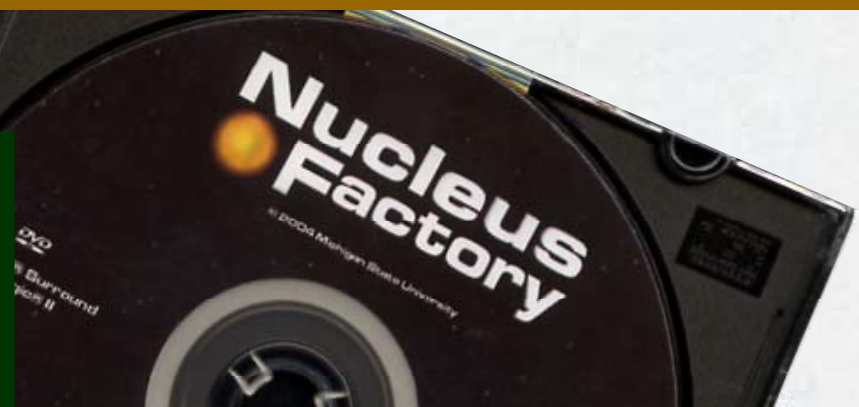
JINA

Successes

- **Classroom Materials Mini-Grants –**

  By providing stellar classroom materials, we enhance the science curriculum of K-12 classrooms at every level. For relatively little cost (averaging around $5 per student), we have reached some 25 teachers, 154 classes, totaling 3150 students in three years!

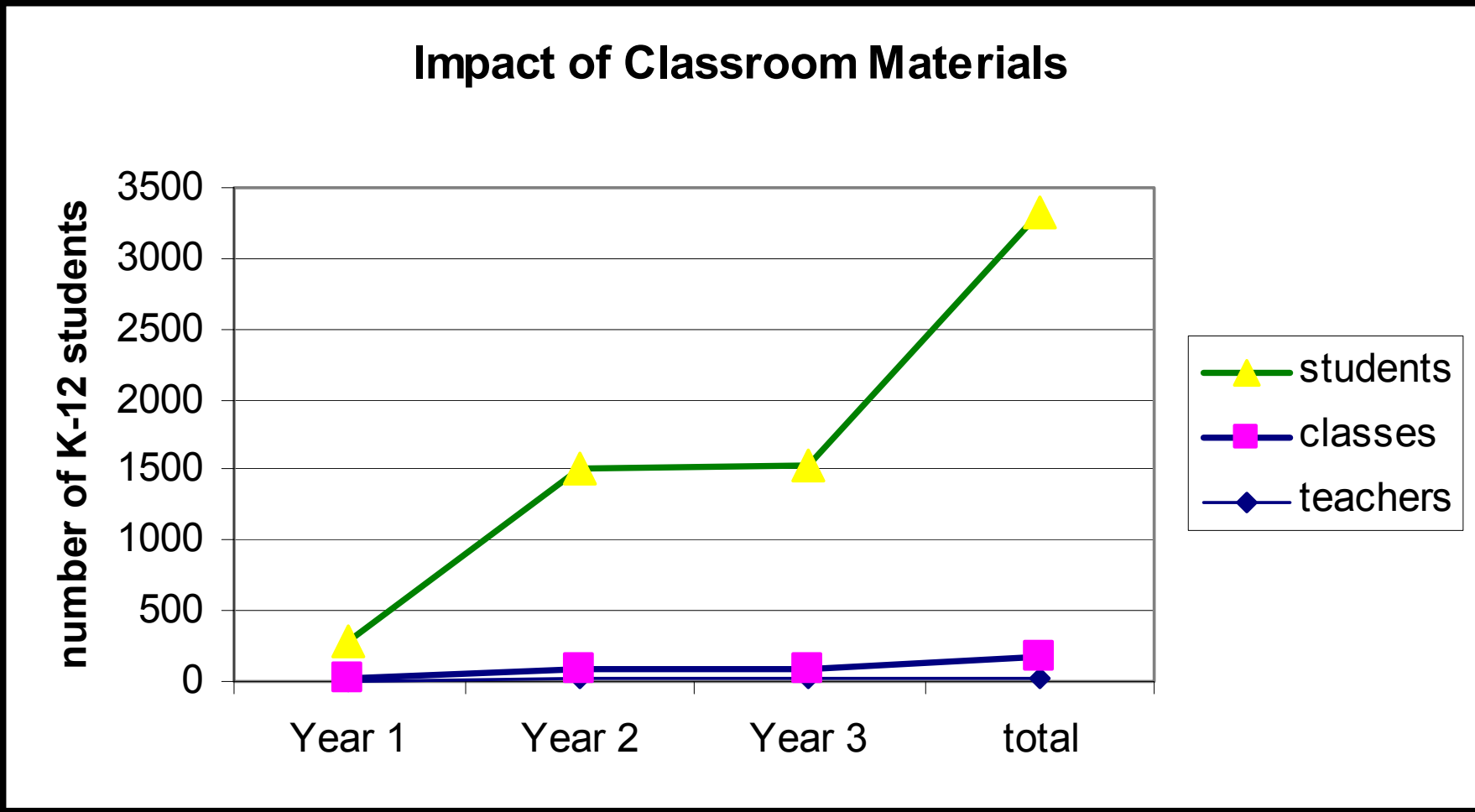
In addition to the materials provided by the CMG program, we have given out dozens of copies of the Nucleus Factory, a documentary about the NSCL.



Teacher Testimonial

"The mini-grant materials will have come at an ideal time. We have just integrated the Michigan Space Science objectives into our curriculum. While our new Holt textbook covers some information well, we need better visuals and some hands on minds on activities for the kids to really embrace these integrated topics. Our district has cut funding and we do not have monies to maintain the current curriculum let alone the newly adopted material. I fear that we will not be giving the time to the interesting concepts that space science offers without materials to support our teaching."

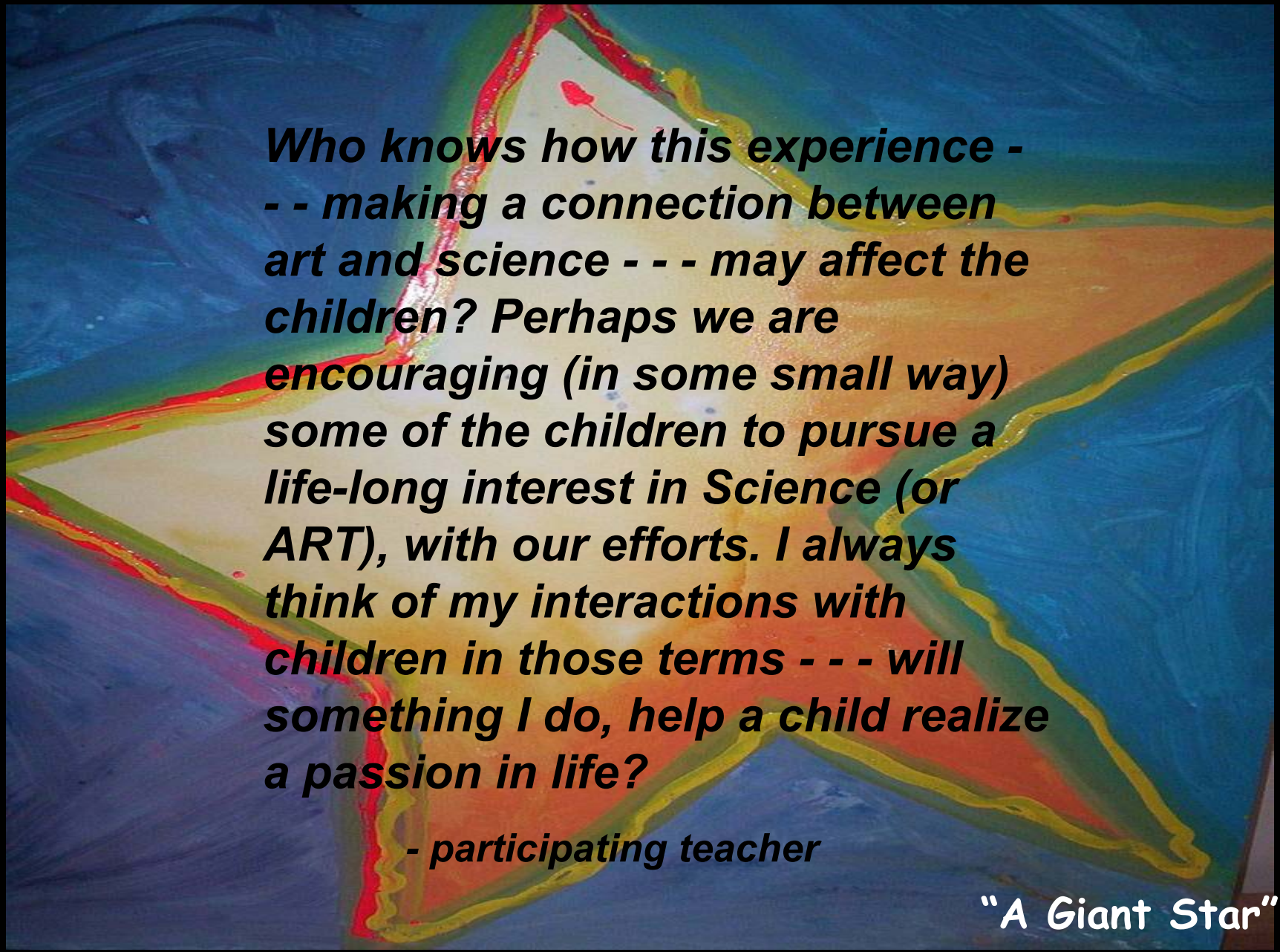
Eaton Rapids High School in Michigan
Chemistry, Natural and Environmental Science


Impact of Classroom Materials
number of K-12 students
3500
3000
2500
2000
1500
1000
500
0
Year 1
Year 2
Year 3
total
students
classes
teachers

Successes

From ART to SCIENCE: Igniting Stellar Imaginations

- **Honors:** – a Participating teacher has won a national teaching award for integrating art in the curriculum
- **Publicity:** This project has been noted by local press three times in South Bend and twice in Michigan
- **Product:** The artwork produced through the project is beautiful and makes for excellent exhibits with other publishing possibilities
- **Audience Reached:** Continuous expansion and adaptation, reaching over 1000 children!
- **Local School District Adoption:** Part of the Curriculum & Teacher Training at ETHOS in Elkhart, Indiana



"Stars are very big and bright, but you cannot see them when it is raining outside."

by Kenyon (5)

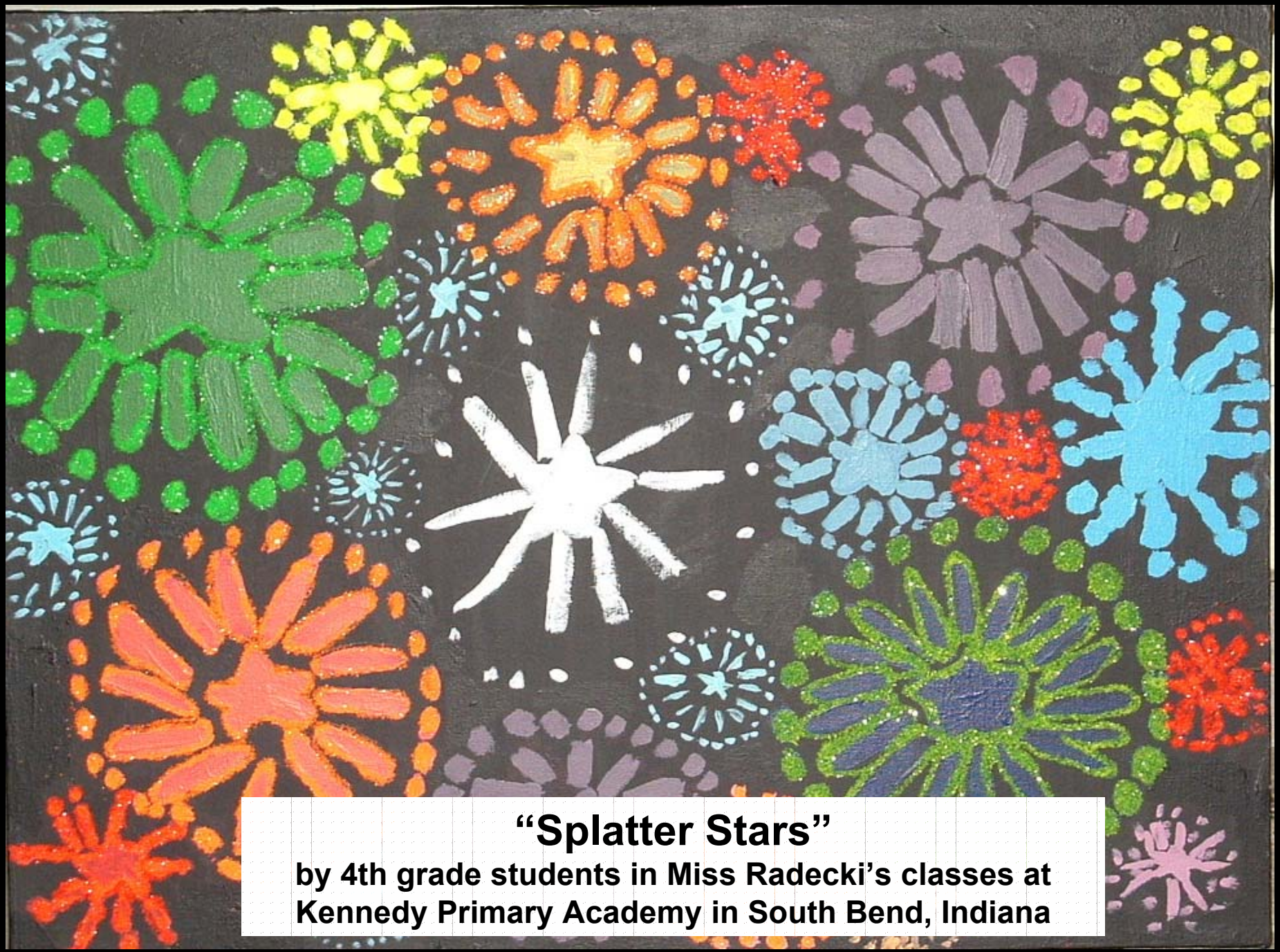
From ART to SCIENCE: A JINA Outreach Project

JINA

By over 100 3rd and 4th grade students @ Bennett Woods Elementary, Okemos MI - NSCL Unveiling April 23, 2005

The Joint Institute for Nuclear Astrophysics
www.JINAweb.org

JINA


“Splatter Stars”
by 4th grade students in Miss Radecki’s classes at
Kennedy Primary Academy in South Bend, Indiana

"Dark City with Black Cat"

"The city is dark and sometimes black in the evening. Sometimes you can see the moon and stars and clouds and a cat."

By: Kenyon (age 5), Tokesha (age 5) & Lexis (age 5)

YOUTH IN NEED, St. Louis, MO

"Sometimes in the morning when I come to school, I can see the sun and the North Star. The North Star is the brightest star and never moves. Sailors ask him for directions."

"Sun and North Star"

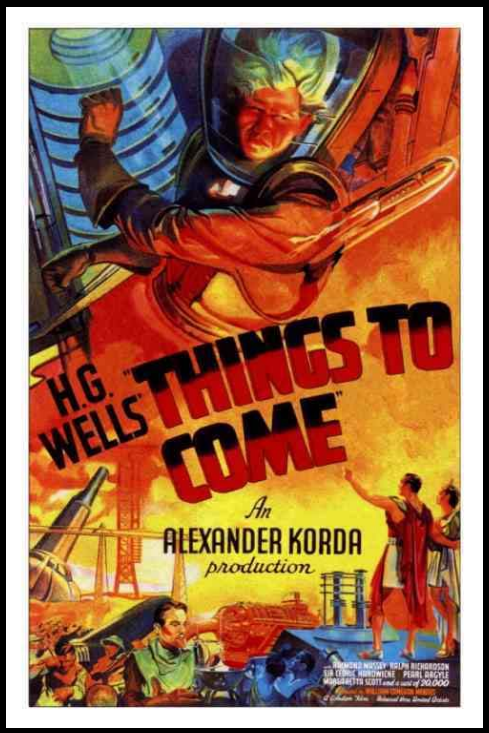
Brandenisha (age 5) & Ebony (age 4)
YOUTH IN NEED, St. Louis, MO

Success Summary

- Overall JINA has reached over 4000 K-12 teachers and students in 3 years!
- We have expanded our best programs to new sites, demonstrating growth
- We have successfully secured external funding to implement new programs
- We have created new products
- Our collaboration efforts are strong and growing

And there is more:

Things Not Really Mentioned - Public Events



physics & film series

sponsored by the Joint Institute for Nuclear Astrophysics
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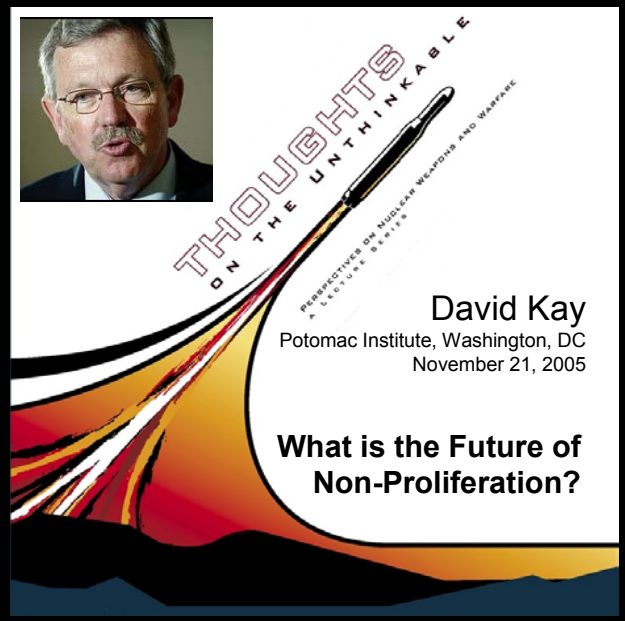
Summer and Fall 2005



Thoughts on the Unthinkable:
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A Public Lecture Series, Fall 2005