Delaware Space Grant Consortium

November 2011

Space Grant in Delaware

- Affiliates:

  --- Univ of Delaware

  Newark, Lewes

  – Delaware State Univ. Dover
  – Del Tech Comm. College

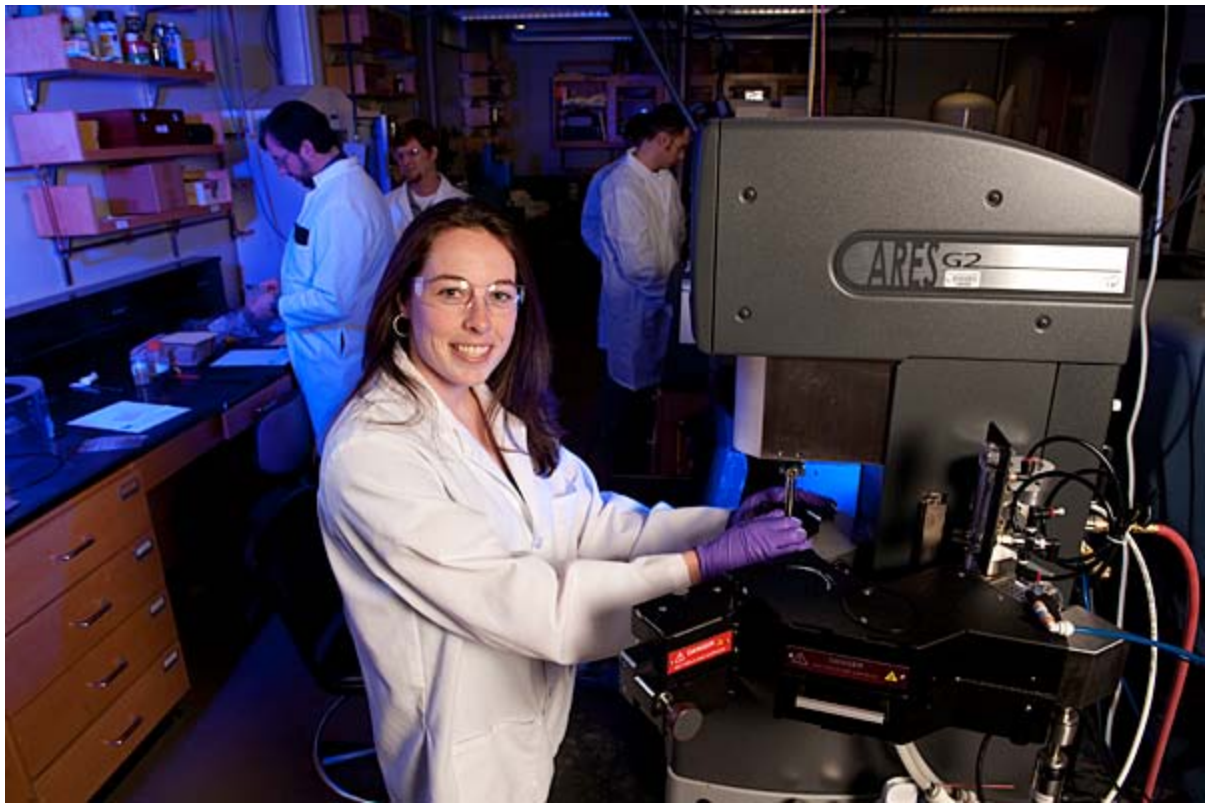
    Stanton,Dover, Georgetown,Wilmington

  – Goldey-Beacom College
  – Wilmington Univ
  – Wesley College, Dover
  – (In PA: Swarthmore, Villanova)

Graduate fellowships

- 8 with full-year stipend
- Two research institutions in the state: Univ. of Delaware, Delaware State Univ.
- Departments: Chemical Engineering, Mechanical Engineering, Geography, Physics and Astronomy

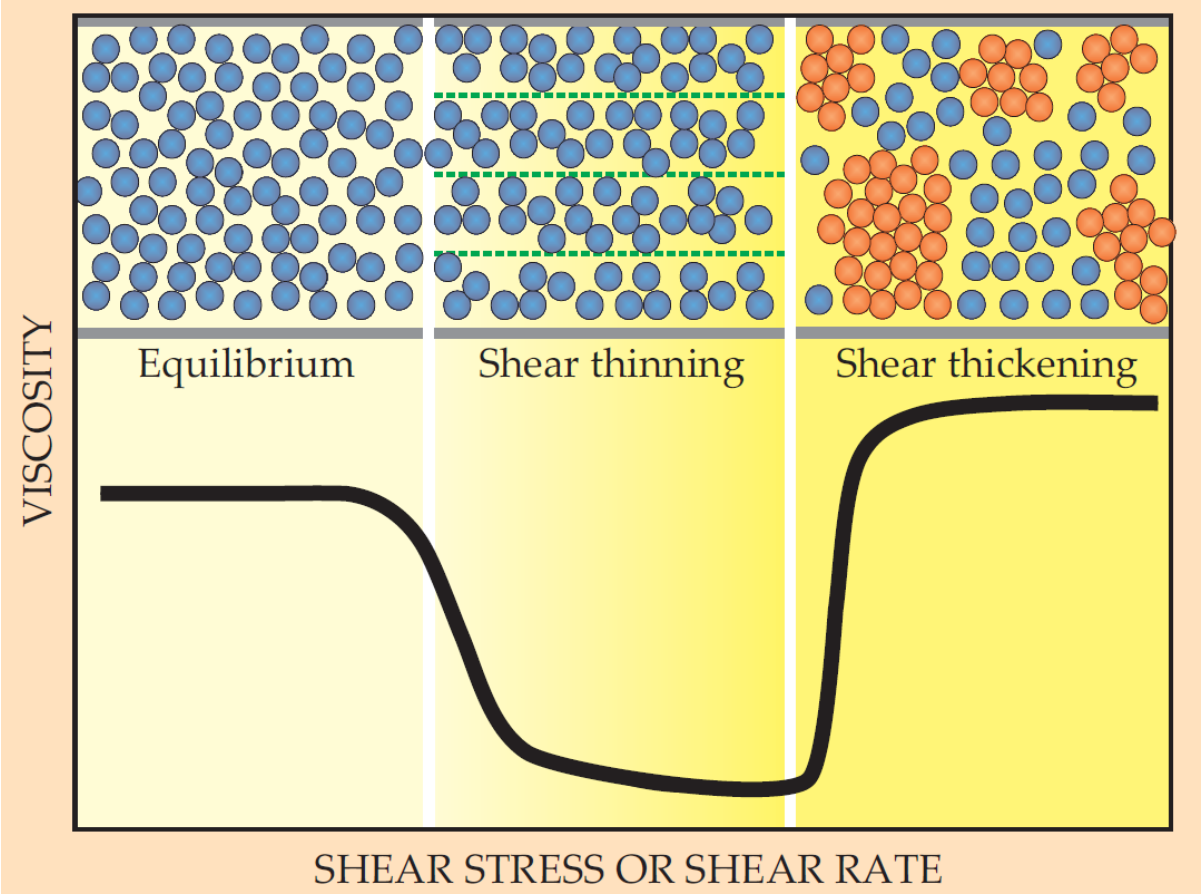
1. Kate Gurnon: space suit material and meteoroid protection



- Chem. Eng.

UDaily 6/9/11

Shear Thickening Fluids



STFs respond differently under different shear rates and stresses.

The suspension's underlying microstructural rearrangements result in the macroscopic thinning and thickening responses.

The shear thickening response is completely reversible. If the applied stress (or shear rate) ceases the microstructure returns to an equilibrium state.

Wagner and Brady (2009). "Shear thickening in colloidal dispersions." *Physics Today* **62**(10): 27-32.

Summary

STFs respond aptly to dynamic deformations and demonstrate thinning and thickening over a single cycle of oscillation.

These novel properties lend themselves to a number of new dynamic applications.

The Large Amplitude Oscillatory Shear (LAOS) experimental studies performed are now being used to develop a constitutive model for STF.

This model will provide predictions for a STF's response under conditions not experimentally accessible, e.g. in space.

The research program is being carried out in collaboration ***with ILC Dover***, the company which makes spacesuits for US astronauts:

(Synergy between Space Grant and NASA/EPSCoR)

2. James Dalessio (UD Phys/Astro)

Astronomical observations of pulsating stars: use the pulsations to study the internal structure of the star ("asteroseismology")

Observe a target star for many nights (and days) continuously
How?
Coordinated observations at multiple observatories distributed around the "whole Earth"

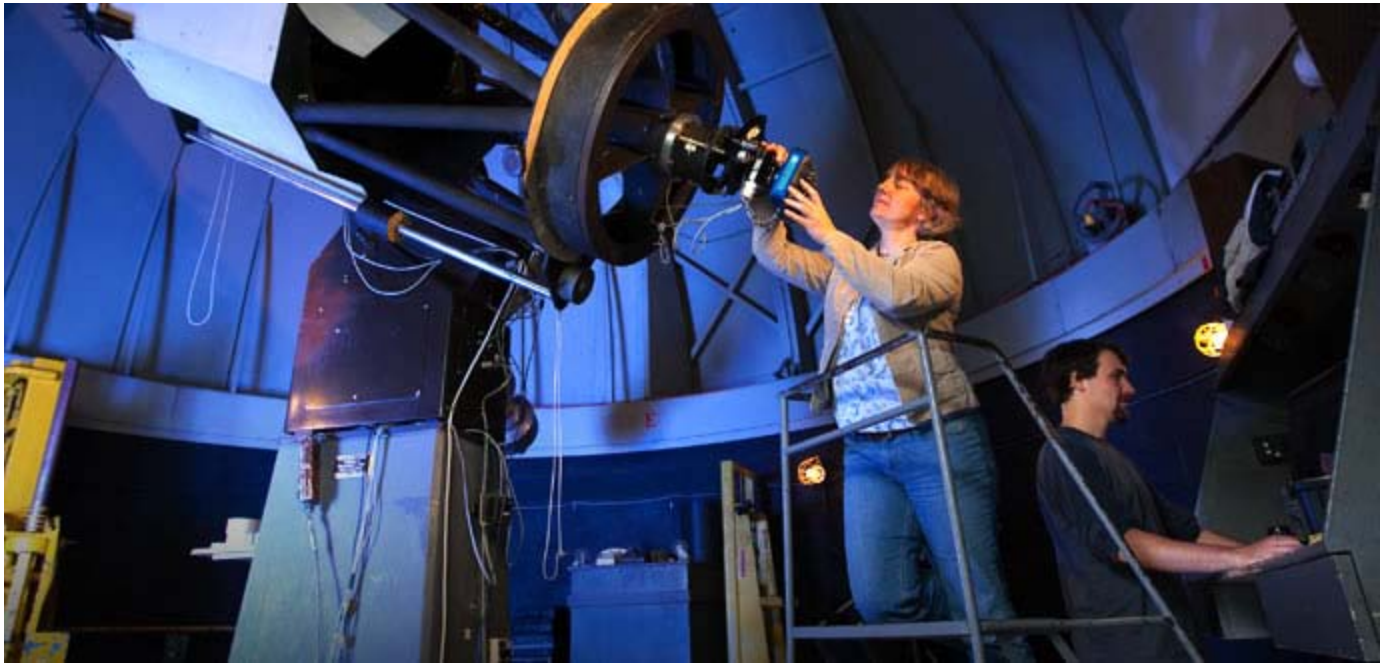
Whole Earth Telescope (WET) Campaign XCOV28

- J.D. will be in command of the entire WET, over 25 telescopes, from Nov 30 - Dec 5
- Principal investigator of 2 of the targets
- Asteroseismology of each target yields information about the internal structure of the star

- Mt Cuba Observatory: Dr J. Provencal and J. Dalessio

UD Home Page:
“Discovery learning”

Photometry of stars



J.D.'s Software Suite: "Maestro"
Now debuting for the WET!

- Maestro can convert thousands of images into a light-curve
- Up to 5% improvement in final data quality over IRAF
- Robust, stable version has yet to fail
- Fully automatic reductions
- Has officially replaced custom IRAF routines for WET
- Used by astronomers all over the world
- Dramatically reduced the required manpower for a WET campaign

3. Studies of low-noise magnetometers for use on spacecraft

- Ryan Stearrett (Dept of Physics/Astronomy, Univ of Delaware)

- A *magnetic tunnel junction* (MTJ) consists of two layers of magnetic metal, such as cobalt-iron, separated by an ultrathin layer of insulator, typically aluminum oxide with a thickness of a few nanometers.
- Insulator is so thin that electrons can “tunnel” through the barrier.
- In MTJs the tunneling current depends on the relative orientation of magnetizations of the two metal layers:
- An applied magnetic field changes the magnetizations.

Detecting magnetic fields

- Low-frequency resistance noise limits the performance of magnetic tunnel junctions (MTJ's)
- Currently, fluxgate magnetometers meet the high sensitivity requirement for magnetic sensors used by NASA spacecraft but consume ***several watts*** of power.
- (N. F. Ness, first Director of DESGC, built fluxgate magnetometers for 20 space-craft, including 2 which have now gone outside the solar system)

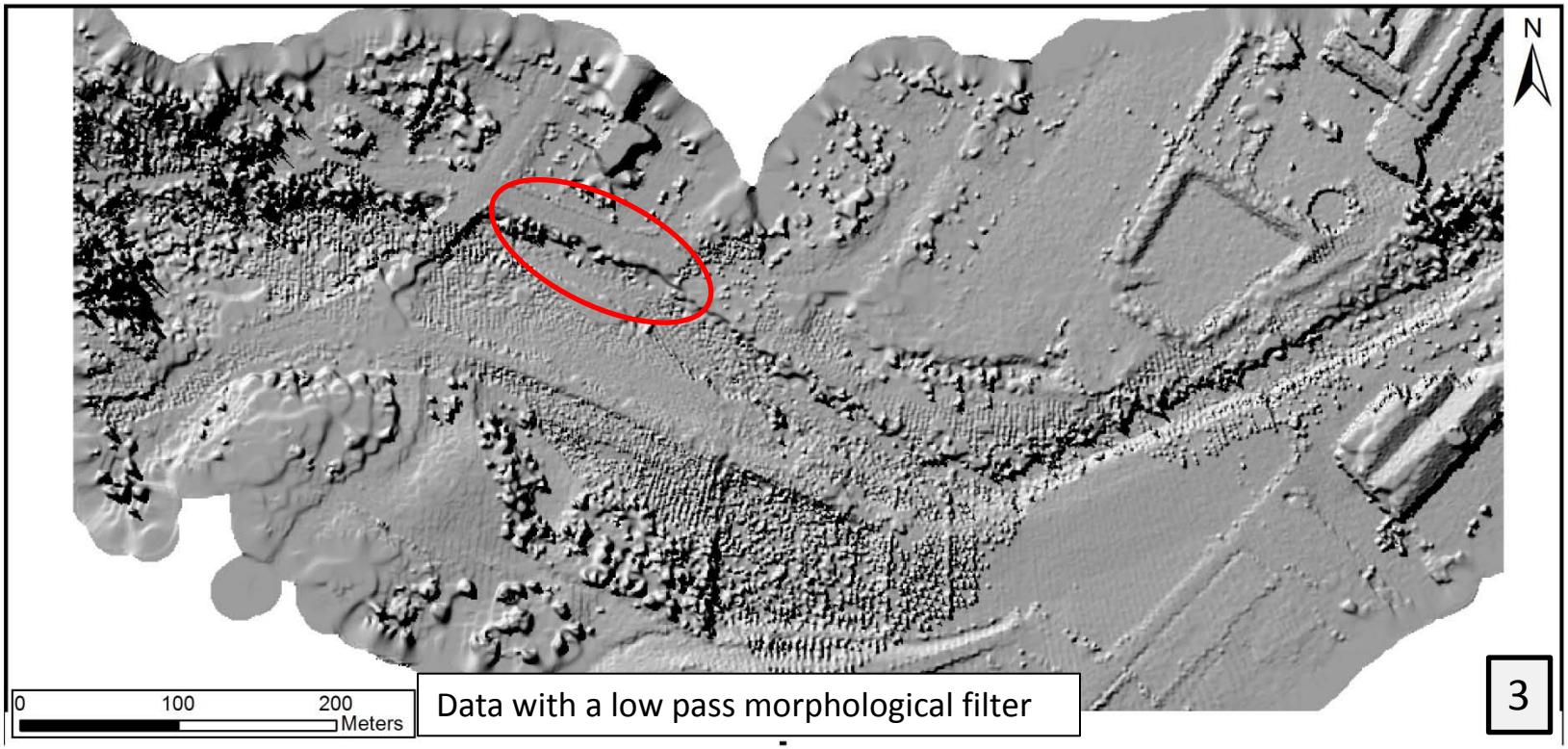
Low-power magnetometer

- MTJ's in a series array, like a Wheatstone bridge, these provide a low-power magnetometer: the power use is only several ***MILLI***watts
- *MSJ design combines low power and high sensitivity: possible new detectors for magnetic fields in the solar system*

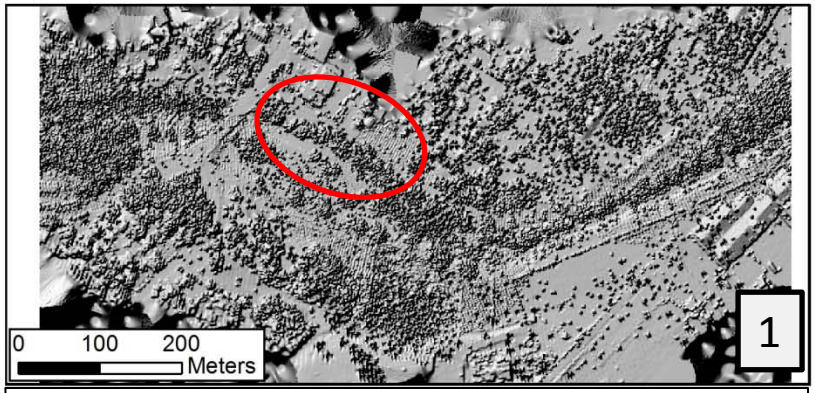
4. Revealing the Geomorphic Characteristics of a River Channel Bottom

- Researcher: *Daniel Hubacz* (Geography Dept, UD)
- Goals: Define the spacing between pools and riffles in the South River, Virginia, from an analysis of Airborne LIDAR flown by the USGS in 2010
- Earth Sciences: remote sensing study
- Riffles are the preeminent feature of coldwater streams: a food source, a shelter from predators, a hedge against oxygen depletion, and a conveyor belt that brings food to fish. The broken water surface hides the fish, and riffles also oxygenate the water.

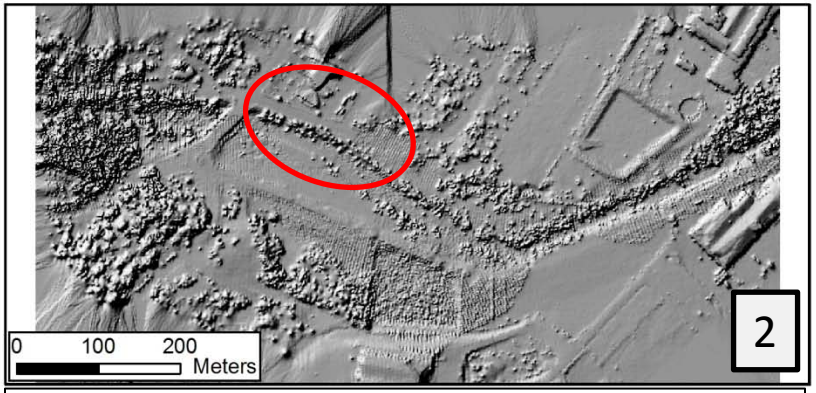
Hillshades of Airborne LIDAR Points from a section of the South River, Virginia: Notice the decrease in noise within the red circle with the application of each filter (1-3). The filters require more fine tuning to increase their ability to reveal the river bottom and ultimately the spacing of pools and riffles in the South River.



Data with a low pass morphological filter

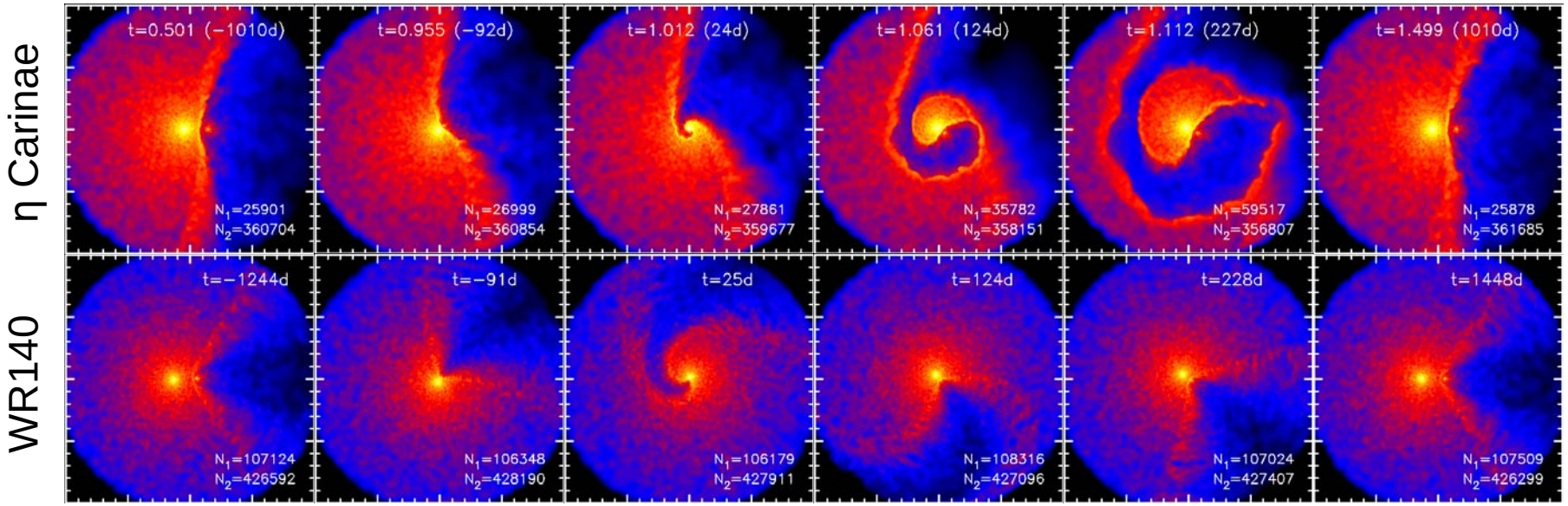


Raw data extracted from USGS dataset using ALPS



Data with a custom high pass filter

5. Using Hydrodynamic Simulations to Model the X-ray Properties of Colliding Wind Binaries (CWBs): Chris Russell



Snapshots of log density in the orbital plane of 3D SPH simulations of the long-period, highly eccentric CWBs η Carinae and WR140

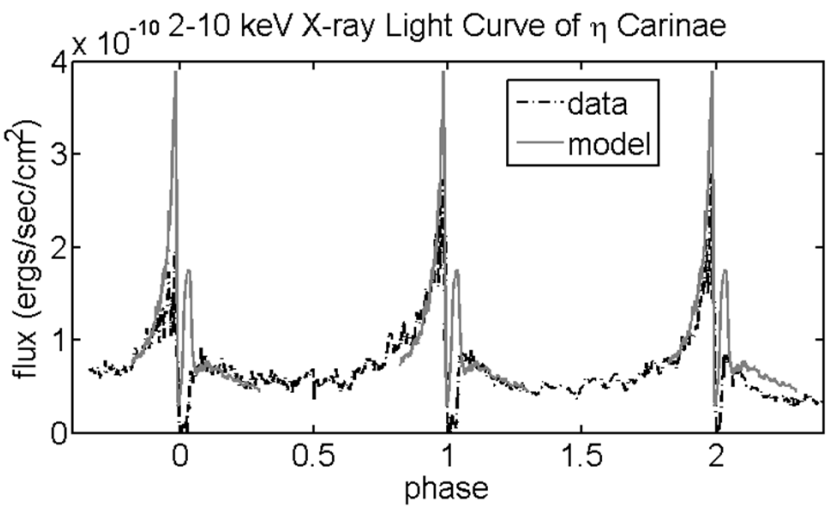
Massive stars have strong winds: mass loss rate $\leq 10^{-3} M_{sun}$/yr, $v_{wind} \leq 3000$ km/s

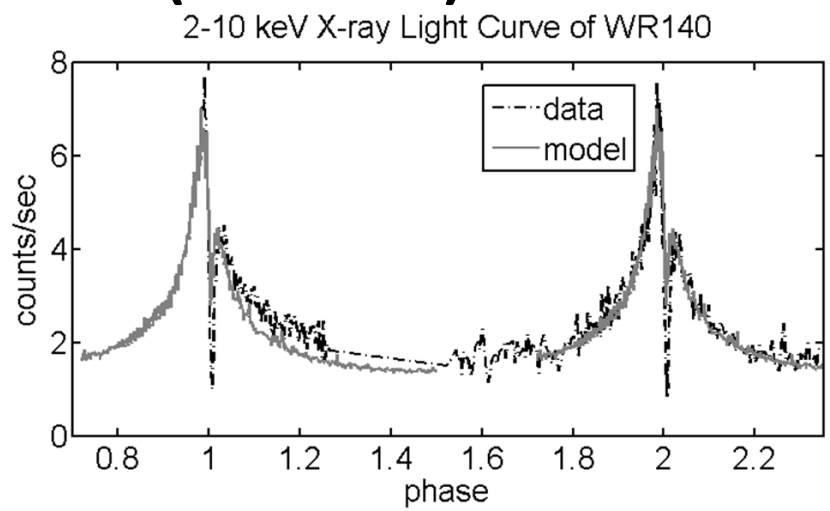
→ Winds collide when stars are in binary systems

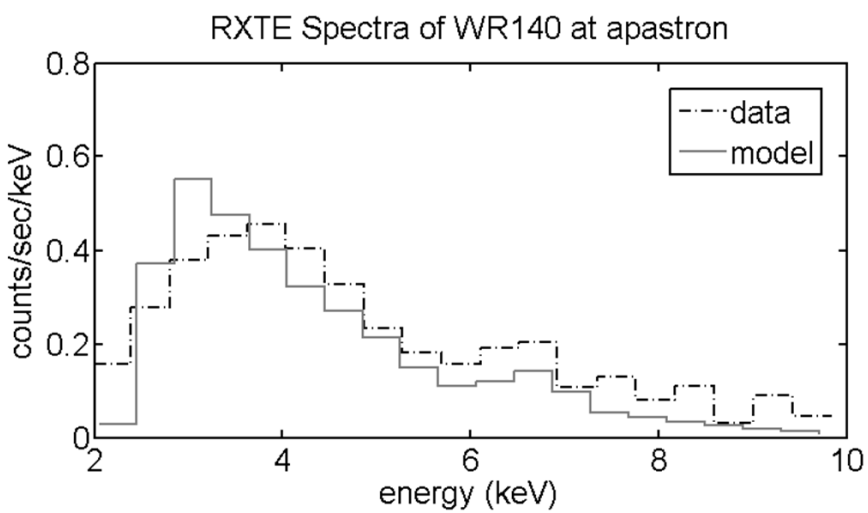
→ Produce temperatures of 10^7-10^8 K

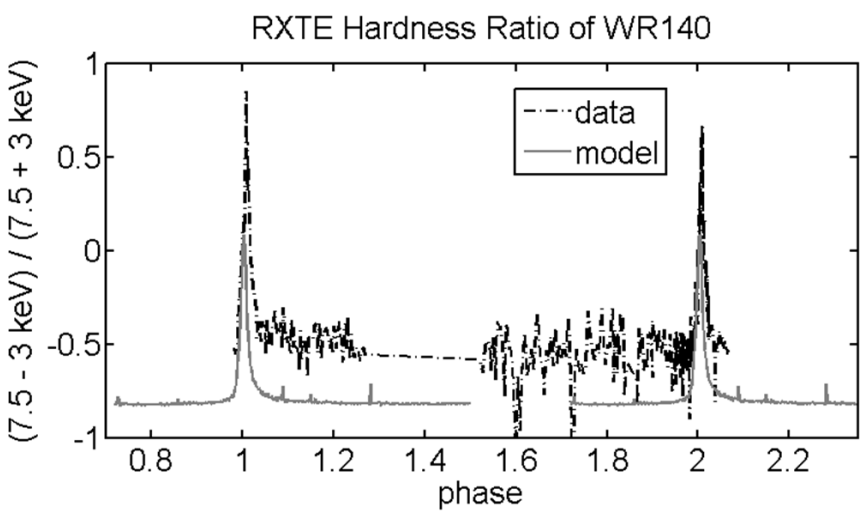
→ Generate thermal X-rays that are monitored by RXTE, Chandra, XMM

Using Hydrodynamic Simulations to Model the X-ray Properties of Colliding Wind Binaries (CWBs)









- 6. Asia Dowtin: UD Dept of Geography
- Delaware Geographic Alliance
- Implementing DE State Geography standards in DE schools

Progress to Date

- Created an interactive display for students and adults that was a part of the University of Delaware's annual Coast Day event in Lewes DE (Oct. 1, 2011) (Sea Grant).

- The display encouraged students to explore communities in coastal Delaware
- Promoting this year's theme for National Geography Awareness Week: Explore Your Community.

- The display highlighted 5 coastal communities, providing facts about their history and information about places to visit/ explore within those communities.

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Chitosan Nanoparticles as a Drug Delivery System for Autism Treatment

7. Kimberly A. Milligan
Ph.D. Student
Dept of Chemistry, Del.State.U.

Autism Research

Chitosan (polysaccharide) nanoparticles (CSNPs) have been investigated for delivering peptides to the animal brain and have shown great potential for therapeutic applications.

In this study, oxytocin-loaded chitosan nanoparticles have been synthesized and characterized for proposed extended hormone release in the brain for autism treatment.

J.-H. Park (UD Mech. Eng.)

- Kinematic Design of an Asymmetric In-Phase Flapping Mechanism for Micro Air Vehicles (MAV's)
- **Objective**: Introducing a novel design of flapping mechanism inspired from direct flight muscles of thorax in insect.

✓ To turn, insects differentially vary the flight patterns of their two wings, specifically, asymmetrically changing the wing amplitude angles

- while keeping the in-phase motion to gain lateral dynamics and attitude stabilization.

✓ My design was focused on this asymmetric flapping motion generated from the direct flight muscles of insect and was aimed to incorporate this specific feature into the mechanical model

Research Infrastructure Development

- Dr Cherese Winstead Dept of Chemistry at DSU, “Chemical and Polymer Functionalization of Nanodiamonds”

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- Diamond: excellent physical properties such as hardness, optical transparency, thermal expansion, thermal conductivity, electrical insulation, chemical corrosiveness, and biocompatibility [1-4]. Nanodiamonds (NDs) have versatile applications in electro-optical devices, sensors, and biomedicine.
- Combining nanoparticles and biomaterials into an integrated system for applications in drug delivery or bioanalysis has become a key interest in nanobiotechnology [2].

RID: Dr Cherese Winstead

- The optimal method of efficient targeted delivery would be to combine the advantages exhibited by biopolymers, such as ease of use, biocompatibility, and biodegradability with the mechanical stability of synthetic polymers.
- Therefore, the aim of this work is two-fold:
- (1) to synthesize functionalized nanodiamonds using heat and acid treated pretreatment processes to generate carboxylated-NDs (ND-COOH) to enable covalent bonding with biomolecules; and
- (2) to generate polymer functionalized NDs which will exploit the electrostatic interactions existing at the ND surface and polymer *via* surface-immobilization.
- The coupling of biopolymer drug delivery systems with NDs promises a new generation of drug delivery technology.

DASEF's Professional Development Supported by Space Grant

DASEF's standard's based Professional Development in conjunction with information and resource distribution impacts educational practice.

Educator Eyes on the Skies

During the Eyes workshops, teachers looked back at the Earth and out into the Universe, experienced the Star Lab and observed the stars in the Mountjoy Observatory using DASEF's 16" Meade Telescope. Each teacher constructed their own Galileoscope. NASA materials and resources were distributed.

National Air and Space Museum

Teachers visited NASM and had the opportunity to see hundreds of original, historic artifacts on display, 22 exhibition galleries, flight simulators, and the Albert Einstein Planetarium.

DASEF STEM Partnership and NASA Linkage Programs Supported by Space Grant

Build strategic linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.

1. **Academies, Workshops, Saturday Explorations, STEM Events and Astronomy Programs are coordinated throughout the year. Information about NASA missions is communicated and NASA materials are distributed.**

2. **Provide STEM programs in conjunction with diverse organizations in the state:**

   AAUW, 4-H, Girl and Boy Scouts, Girl's Inc., Girl's and Boy's Clubs, STEM Family Days,

   Department of Energy, Delaware Department of Natural Resources, DE Technical and Community College, CAP Education Programs and more.

Rockets for Schools: School Challenges Supported by Space Grant

Rocketry Challenges for Schools

This Statewide rocketry program is designed to:

- Assist teachers and CAP instructors as they use rocketry as the unifying theme for teaching STEM and non-traditional career choices, skills and technology.

- Includes a "teacher self-training" based on the NASA Rocketry Book to teach the Laws of Physics and a “how to guide” to construct the various rockets.

Approximately 20 educators from 14 schools within the State of Delaware and 10 squadrons participated in the annual Rockets for Schools program held in May at Cape Henlopen State Park.