Russell 1834, discovers "solitary wave"

KdV: \( u_t + 6uu_x + u_{xxx} = 0 \)

shallow-water waves

acoustic waves in plasma

1-soliton solution

\[
u = 2\beta^2 \sech^2(\beta x - 4\beta^3 t + \epsilon)
\]

\(n\)-soliton solution in terms of matrix triplet \((A, B, C)\)
Premarin Stability At High Temperatures
Lauren Tedmon, Mentors: Kevin Schug and Hien Nguyen

- Premarin is a complex cocktail of estrogen and hormone metabolites
- Estrogen hormones hypothesized as a treatment for traumatic brain injuries
- Before it can be used as a first-response treatment, the stability of the reconstituted (ready-to-inject) drug has to be verified
- Long-term stability showed degradation and a few estrogen conversions
- Studying conversion of estrogen components with pure standards
The Impact of Pain on Memory

Kaitlyn Riley, Mentor: Perry Fuchs

• **Purpose**: To increase knowledge of memory processing in pain conditions

• **Animal Models**: Mimic clinical conditions and allow generation of knowledge for later translational application

• **Methods**: Provide repeated exposure across multiple days to explore the development and persistence of memory trace

• **Expected Results**: Subjects will develop enhanced escape and avoidance behavior with repeated testing

• **Implications**: An understanding of memory mechanisms in pain processing will lead to novel therapeutic approaches for chronic pain
Exact Solutions to the Degasperis-Procesi Equation
April Delgado and Jasmine Kendricks, Mentor: T. Aktosun

DP: \[
\frac{\partial u}{\partial t} - \frac{\partial^3 u}{\partial t \partial x^2} + 4u \frac{\partial u}{\partial x} = 3\left(\frac{\partial u}{\partial x}\right)\left(\frac{\partial^2 u}{\partial x^2}\right) + u \frac{\partial^3 u}{\partial x^3}
\]

- Models wave breaking
- 1-soliton: \[u = \lambda \exp(-|x + \lambda t + \beta|)\] \(\lambda = 2, \beta = 1\)
- *Mathematica* used for analysis and animation
- Multi-peakon soliton solutions
Pipe Leak Detection Using Acoustic Emission

Jose J. Tinoco, Mentor: Haiying Huang

- Goal: To build an experimental setup to demonstrate pipe leak detection
- Piezoelectric patch sensors and commercially available acoustic emission sensors are used to collect acoustic emission signals
- Signal processing is utilized to time correlate signals and find pipe leak location
- Experimental setup will serve to demonstrate Dr. Huang's patented wireless acoustic emission sensors
- Resources: Papers on leak detection, LabVIEW, MATLAB, Oscilloscope
Optimization of Inverted Notched Fin Arrays for Natural Convection

Betsegaw Gebrehiwot and Marianna Vallejo, Mentor: D. Agonafer

- Typical fin performance
- Performance of INFA in vertical position versus horizontal position
- Effect of notch geometry
- ANSYS Icepak simulations
- Expected results
  - Vertical position will give better thermal performance than horizontal position
  - Notch geometry will be optimized

Temperature and air velocity profile of INFA in horizontal position
Exact Solutions to the Sine-Gordon Equation
Andrew Velasquez and Jordan Webster, Mentor: T. Aktosun

\[ \frac{\partial^2 u}{\partial x \partial t} = \sin u \]

- SQUID: Magnetic field in the gap between superconductors
- 1-soliton solution: \( u = 4 \tan^{-1}(e^{\alpha x + (t/\alpha)} + \gamma) \)
- More general solutions with any number of solitons in terms of a matrix triplet \((A, B, C)\)
- Animation: \( A = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}, \quad B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \quad C = \begin{bmatrix} 1 & 1 \end{bmatrix} \)
Modeling of a detonation-driven power generator

Ezgihan Baydar, Mentor: Frank Lu

- Pulsed detonation engine (PDE):
  - Utilizes energy from detonations for electric power generation
  - Coupled directly to spring-mass system, linear generator

- Research goals:
  - Determine the dynamical behavior of the linear generator under loading from repetitive detonation waves
  - Determine the power output under parametric variation of detonation force, mass, spring constants, damping, magnetic field strength, internal resistance
Exact Solutions to the Camassa-Holm Equation
Megan Lee and Alex Vourtsanis, Mentor: T. Aktosun

- CH equation
\[ \frac{\partial u}{\partial t} - \frac{\partial^3 u}{\partial x^3 \partial t} + 3u \frac{\partial u}{\partial x} = 2 \left( \frac{\partial u}{\partial x} \right) \left( \frac{\partial^2 u}{\partial x^2} \right) + u \frac{\partial^3 u}{\partial x^3} \]

- 1-peakon solution \( u = \alpha e^{-|x-\alpha t-\beta|} \)

- Analyzing peakons, Mathematica animations
- Surface waves in shallow waters
- Wave breaking, \( n \)-peakon solutions
The Design and Synthesis of Alternative HMP-Kinase Substrates
Stephanie Parra, Mentor: Frank Foss

• HMP Kinase (Thi-D) is a key enzyme in Thiamin pathway, a precursor to Vitamin B
• Synthesis of a compound with greater affinity to the enzyme than its natural substrate
• Create an assay to compare the affinity of molecules created
• Discover which intermolecular forces are essential to the binding site
• Compound will be a potential enzyme inhibitor and have possible antibiotic applications
Exact Solutions to the Toda-Lattice Equation
Louis Atsaves and Areeba Ikram, Mentor: T. Aktosun

\[ \frac{\partial^2 u_n}{\partial t^2} = e^{u_{n-1}} - u_n - e^{u_n} - u_{n+1} \]

- Morikazu Toda, Japanese physicist, 1960s
- DNA double helix, crystals, melting solids
- An exact solution: \( u_n(t) = at + b - cn \) \( a, b, c \) constants
- One-soliton solution:

\[ u_n(t) = \ln \left( \frac{1 - e^{-2 \kappa} + \gamma \cdot \exp(-2 \kappa n + 2t \sinh \kappa)}{1 - e^{-2 \kappa} + \gamma \cdot \exp(-2 \kappa (n+1) + 2t \sinh \kappa)} \right) \quad \kappa, \gamma > 0 \]
- Multi-soliton solutions and their analysis
Vapor Chamber Cooling for High Density Materials

Betsegaw Gebrehiwot and Marianna Vallejo, Mentor: D. Agonafer

- Microminuturization and high density packing of chipsets
- Thermal management affects packing density
- Utilization of vapor chamber cooling
- Structural effects on the vapor chamber due to the high-temperature reflow assembly process
- Monitoring parameters:
  - Temperature profile
  - Pressure profile

Vapor chamber operating principles
http://www.1-act.com

Single heat-sink operating over multiple sources
http://www.thermacore.com
Exact Solutions to the Nonlinear Schrödinger Equation

Eleisha Jackson and Sarah Moorman, Mentor: T. Aktosun

• NLS eq: \[ i \frac{\partial u}{\partial t} + \frac{\partial^2 u}{\partial x^2} + 2 |u|^2 u = 0 \]
• water waves, e.m. waves in fiber optic cables
• 1-soliton solution:
  \[ u = \mu e^{i(\alpha x + (\mu^2 - \alpha^2)t + \gamma)} \text{sech}(\mu x + (-2\alpha \mu)t + \delta) \]
• Mathematica animation
• Multi-soliton solutions in terms of \((A, B, C)\)
Systematic Review of Yoga as Intervention for People with HIV/AIDS

Chelsea Roff, Mentor: Andrew Baum

- **Objective:** Analyze effect of yoga for people with HIV/AIDS

- **Methods:** Systematic review and meta-analysis of studies using yoga as a treatment for people with HIV/AIDS

- **Search Terms:**
  - HIV/AIDS
  - Yoga
  - Randomized control trial

- **Selection Criteria:**
  - Randomized control trials
  - HIV+ adults
  - At least twice weekly sessions for 4 weeks or more

- **Ongoing:** Selecting qualifying studies; determining appropriate statistical tests based on sample

- **Future:** Prepare Fulbright grant proposal on yoga for HIV/AIDS patients in Kenya
Surface Flow Visualization
Perla Gonzalez,  Mentor: F. Lu

- Effect of micro vortex generators on a supersonic turbulent boundary layer
- Fluorescent dye in acetone carrier with black light illumination
- Supersonic wind tunnel
  - Mach 2.5, 500 m/s