Dynamics of Masses subject to Counter moving Flows

J. West
ISU, Dept. of Chemistry & Physics
M. Syed
RHIT, Physics & Optical Engineering

Motivation (and Cost)

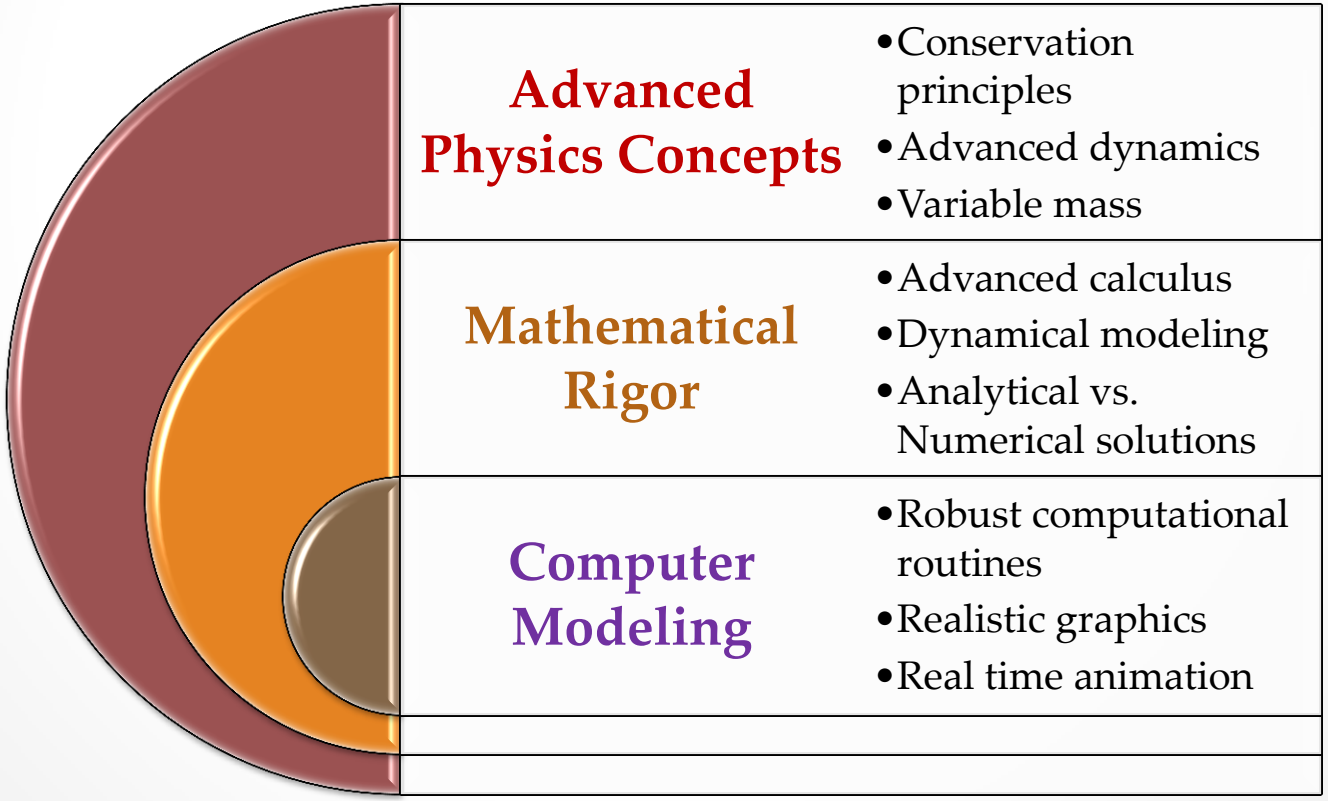
- Programming, Modeling and Numerical Methods are necessary skills
- A Challenging Project is Rewarding and a Portfolio Point
- Options:
- Stand-Alone Course
- Grafted onto a Physics course
- They all COST TIME!! But it IS worth the price

Current Approach at ISU and RHIT

- Indiana State University
  - Students take the introductory course for CS majors
  - Math Methods course (using some ***Mathematica***)
  - PH 310 is required, Sophomore or Junior year (alternates years)
- Rose-Hulman Institute of Technology
  - One introductory programming course (CS 120 or ME 123)
  - One course (EP 280/380, not required, offers some ***Comsol***)
  - Mechanics currently uses Excel (at an advanced level)
- Vpython → Symbolic is easier, Chosen on Purpose

Mechanics Brings Goals Together

The mid-level Mechanics course is an optimal time and environment for programming exposure(Caballero and Pollock (AJP **82** p. 231)



Why Changing Mass

- Changing mass is a challenging/important topic in every Mechanics Textbook
- The timing with stages works well
- Infinitesimal reasoning is a topic with variety and challenge for students (Korff and Rebello, AJP **82**, p. 695).
- Many variations on a basic model, some providing (NEW) analytic solutions, suitable for numerical work
- A student MAY choose their own project, pending Instructor Approval

Project Requirements

- Learn the basics of the language and graphics library via "stages"
- Last Stage: Upgrade to Improved Euler Method
- Mass Accretion Computation Plan (dM, M, scale color effects) must be submitted
- Present results and the program to "the class experts" (Know your audience !!)
- Submit a Final Paper as if submitting to AJP
  - Compare Numerical Results with Analytical Results
  - Compare "fitted" data to analytic expressions
  - GRAPHS!!!!

Assessment

- The project represents 25% of the total grade
- Graphics components are necessary, beauty is voted for and gets bonus points. PHYSICS FIRST!!

Project Score	
Programming and Documentation	5%
Stage Scores (**Timeline is KEY**)	25%
Mass Accretion Computation Plan	10%
Progress Reports (**Random**)	10%
Final Paper	30%
Presentation	20%

Implementation Plan

- Analytic solutions will be submitted for publication (AJP? PRE?) in Fall 2014, with concurrent posting to Arxiv
- Project assigned in PH310 at ISU, Spring 2015
- Project will be an Independent Study or assigned in PH 315 at RHIT, Spring 2015
- Student Project assessment will be included in the Course Evaluation process at ISU in Spring 2015 with results shared at a future conference/in AJP

Possible Configurations

- Falling raindrops and icicles as examples.
- A) Three shapes with sticky mist
- B) One shape + sticky mist + Three Mist Velocities
- C) Prism with Three collision types
- Students take cases in pairs, but work is independent (Debug by Output)

• Shapes:	Prism	Disc	Sphere
• Mist velocities:	Floating	V > v	V < v
• Collision Types:	Inelastic	Catch	Elastic

Cases with Analytic Solution

		Sticky			
	M(x)	M(t)	V(x)	V(t)	X(t)
Static	All	All*	All**	All	All
V<v	All*	All	All**	All	All
V>v	All	P	All	P	None
Fall	All	P, S	D	All	P, S

	Catch		
	X(t)	V(x)	V(t)
Static	Yes	Yes**	Yes
V<v	Yes	Yes	Yes
V>v	No	Yes	No

	Elastic		
	X(t)	V(x)	V(t)
Static	Yes	Yes**	Yes
V<v	Yes	Yes**	Yes
V>v	No	No	Yes

* Can get from M(t) and X(t) or V(x)

** Can get from V(t), X(t)