PACDAS

Norbert Ligterink

* input–dependent "core model"
* core–model based reduction
* fluxes and differential operators
* simulation and initialization
* nonlinear dynamics
* writing and case studies

TWI.6012

14–6–2006, Oce, Venlo

MTNS contribution: (July 2006, Kyoto, Japan)

Physical model reduction of interacting, continuous systems

Symplectic story:

$$\dot{g} = \nabla \cdot J$$

$$\begin{pmatrix}\dot{x}\\ \dot{p}\end{pmatrix} = \begin{pmatrix}0 & I\\ -I & 0\end{pmatrix}\begin{pmatrix}d_x H\\ d_p H\end{pmatrix} \xrightarrow{\text{flux}} \begin{pmatrix}\dot{q}\\ \dot{p}\end{pmatrix} = \begin{pmatrix}0 & D\\ -D^* & 0\end{pmatrix}\begin{pmatrix}d_q H\\ d_p H\end{pmatrix}$$

isolated Hamiltonian port–Hamiltonian

$$\xrightarrow{\text{null space}} \begin{pmatrix}\dot{Q}\\ \dot{P}\end{pmatrix} = \begin{pmatrix}0 & S_+\\ S_- & 0\end{pmatrix}\begin{pmatrix}d_Q H\\ d_P H\end{pmatrix}$$

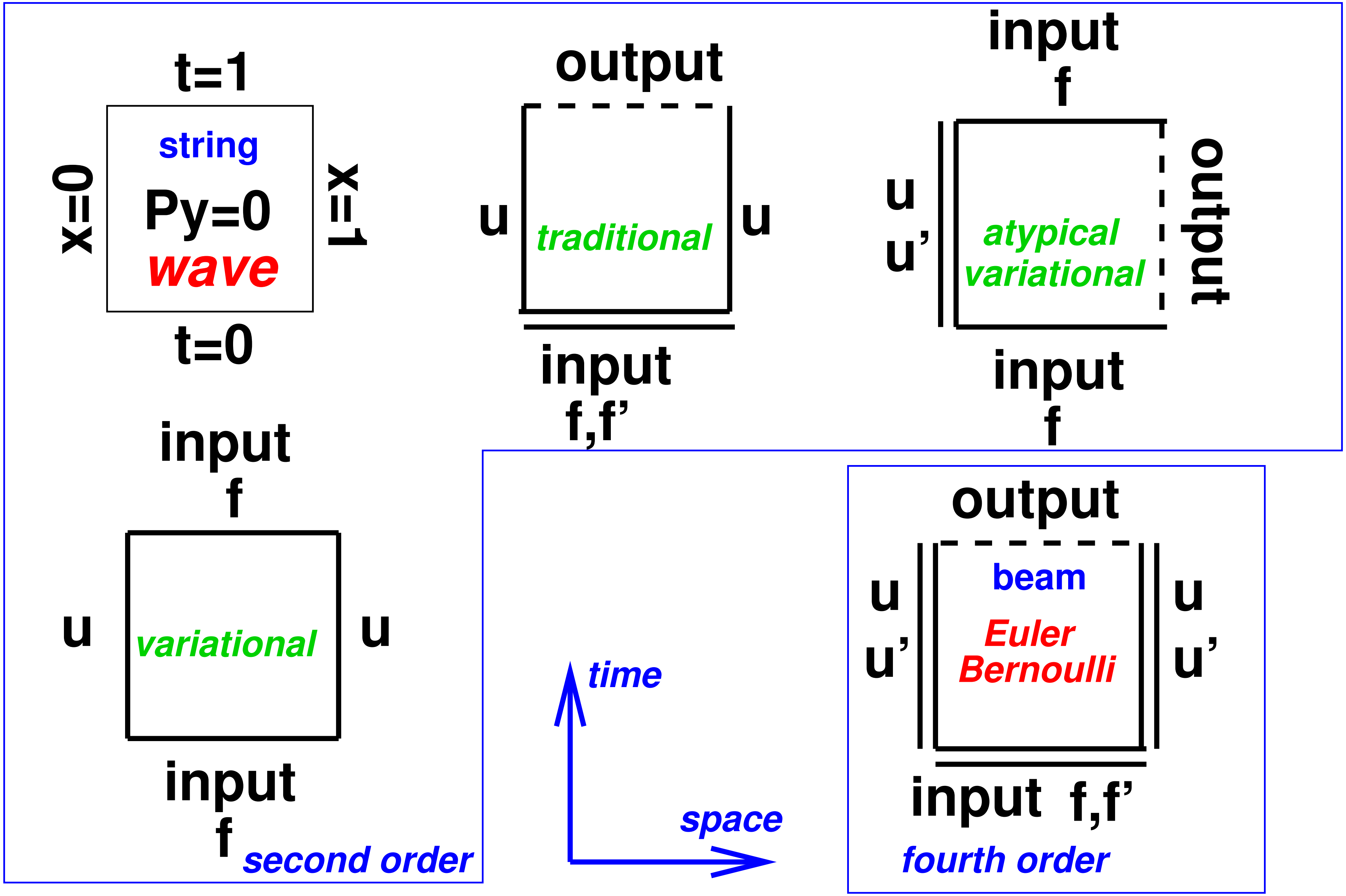
discrete port–Hamiltonian

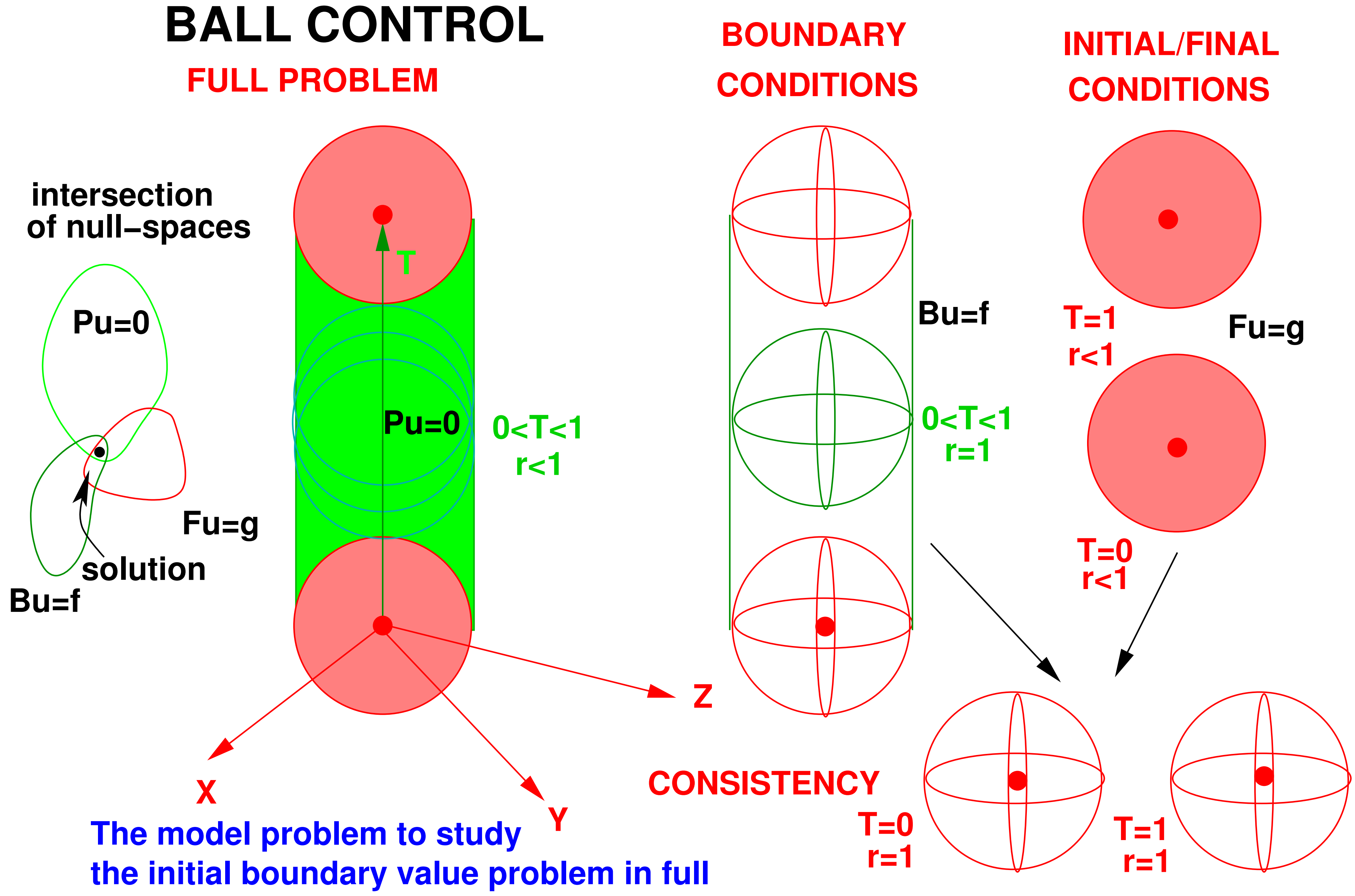
S: half–infinite shift operators

$$S = \begin{pmatrix}0 & 1 & & & \\ & 0 & 1 & & \\ & & 0 & 1 & \\ & & & 0 & 1\\ & & & & 0\end{pmatrix}$$

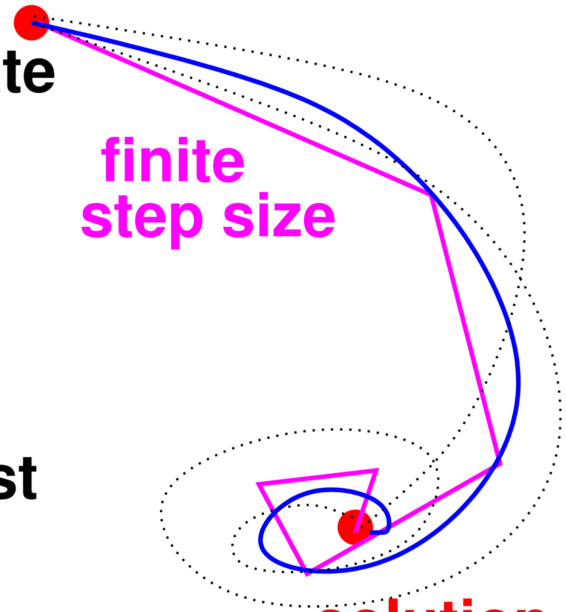
null–space

INITIAL BOUNDARY VALUE PROBLEM




BALL CONTROL
FULL PROBLEM
BOUNDARY CONDITIONS
INITIAL/FINAL CONDITIONS
intersection of null–spaces
Pu=0
Fu=g
solution
Bu=f
T
Pu=0
0<T<1
r<1
Bu=f
0<T<1
r=1
T=1
r<1
Fu=g
T=0
r<1
Z
X
Y
CONSISTENCY
T=0
r=1
T=1
r=1
The model problem to study
the initial boundary value problem in full

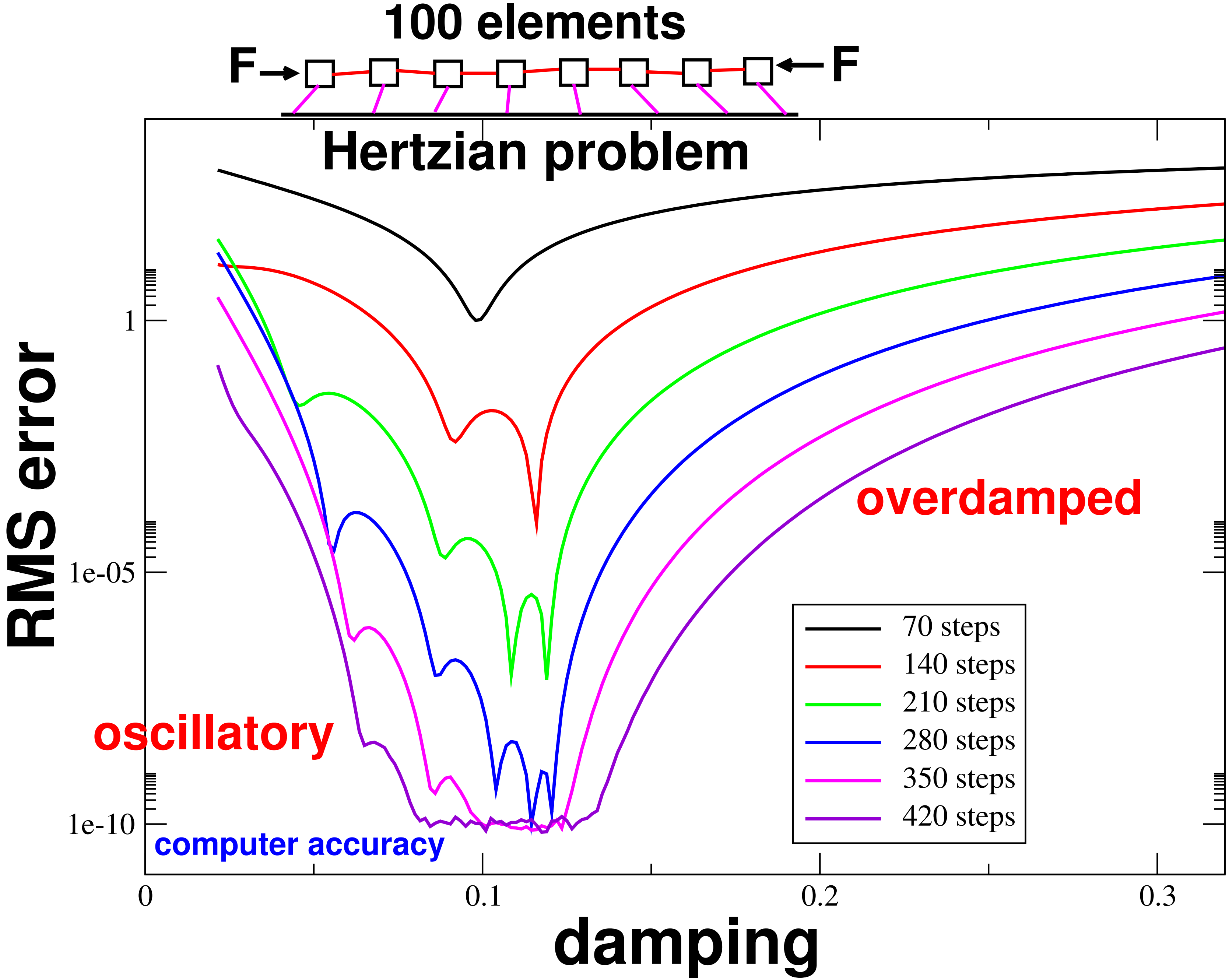
ITERATIVE METHODS FOR LINEAR AND NONLINEAR PROBLEMS



seeking
the smallest
number of
steps

step size limited by ||A||
(improvements by integration methods)

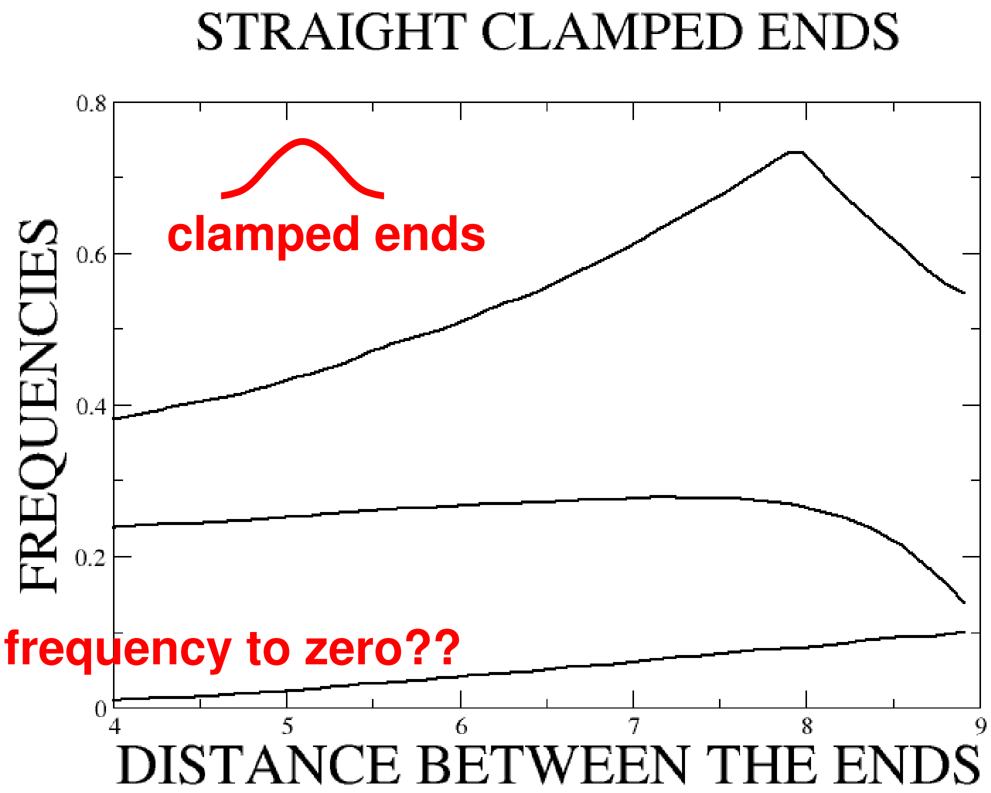
optimal dissipation:
"not too small, not too large"



100 elements
F
F
Hertzian problem
RMS error
1
1e-05
1e-10
0
0.1
0.2
0.3
damping
overdamped
oscillatory
computer accuracy
70 steps
140 steps
210 steps
280 steps
350 steps
420 steps

Multiple solutions for large deformations

CLAMPED BEAM



(related to bifurcation theory of Antman et al.)

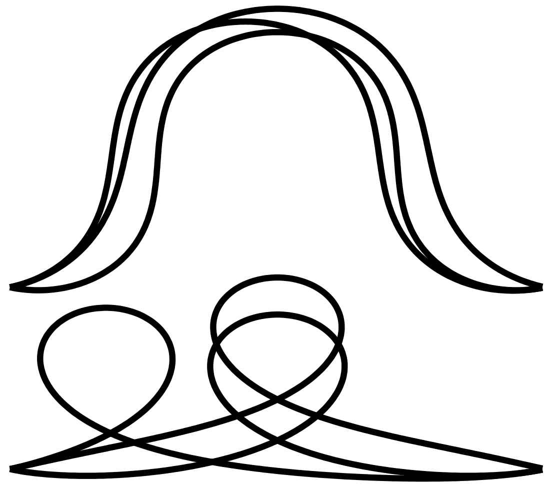
"Swagger signatures"

*cross–over solutions

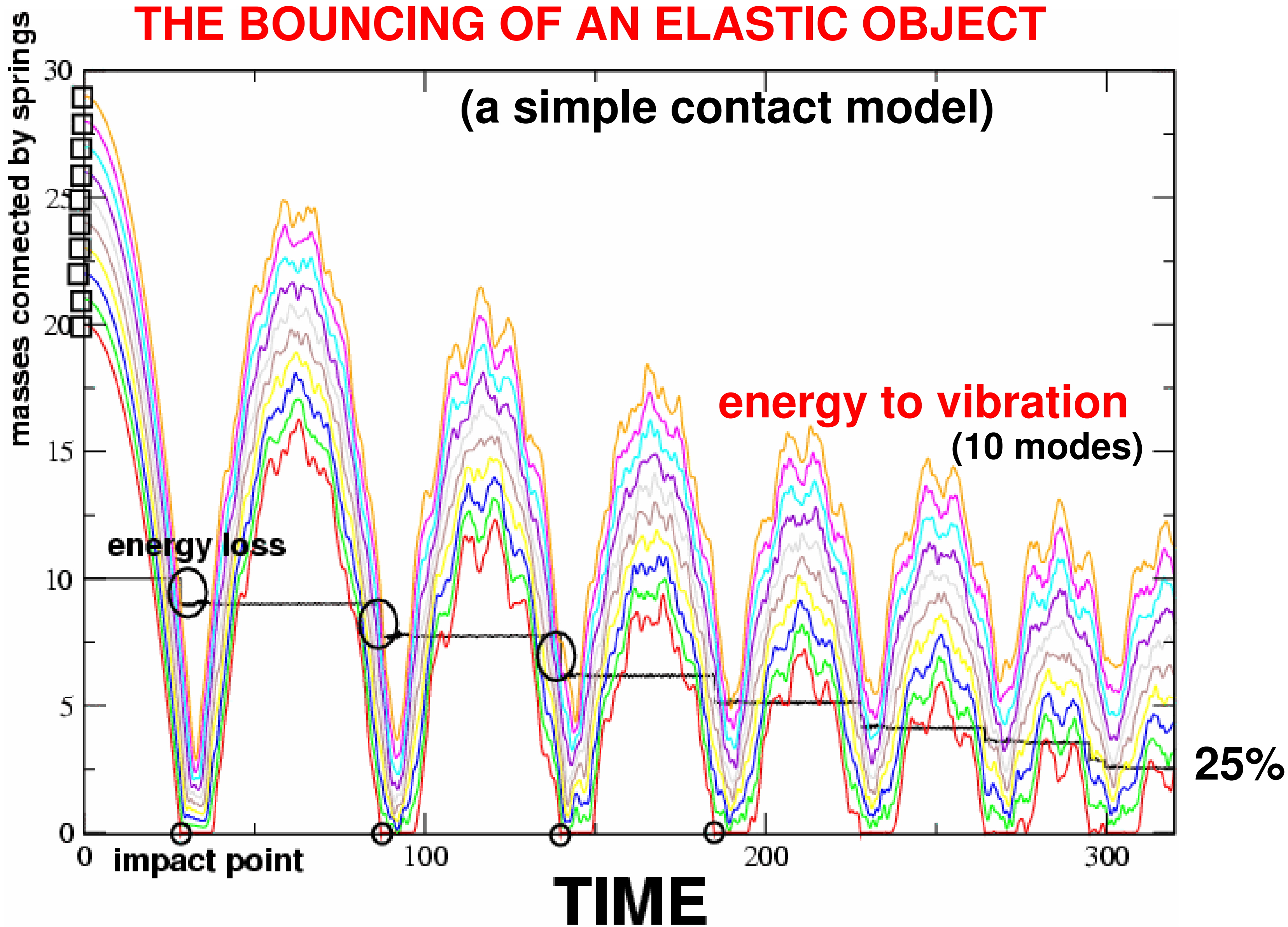
*flat energy minima

*strong bc dependence

solutions for the same boundary conditions



large changes in configuration for small changes in boundary conditions



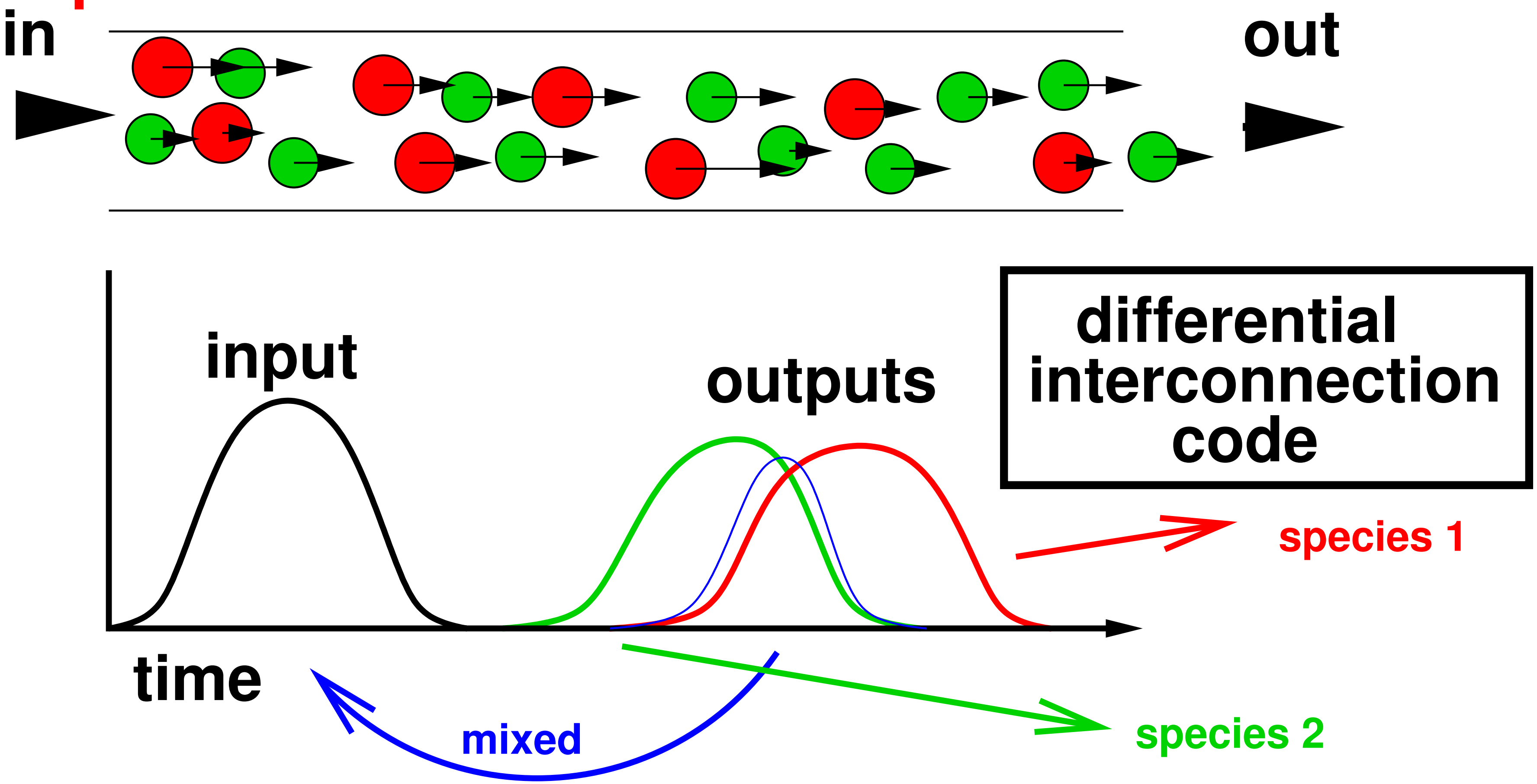
THE BOUNCING OF AN ELASTIC OBJECT
(a simple contact model)
masses connected by springs
energy to vibration
(10 modes)
energy loss
25%
impact point
TIME
0
5
10
15
20
25
30
100
200
300

Two–species Stefan–Maxwell diffusion

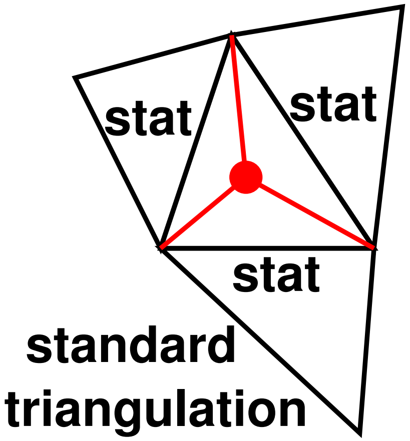
(separation technique)

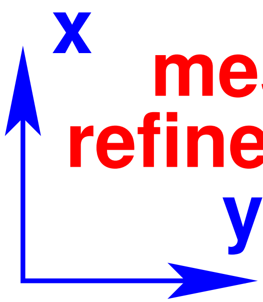
diffusion differences
mutual dependence
nonlinear theory
quasi 3D zeolite

(In collaboration with Lefevre and Couenne)

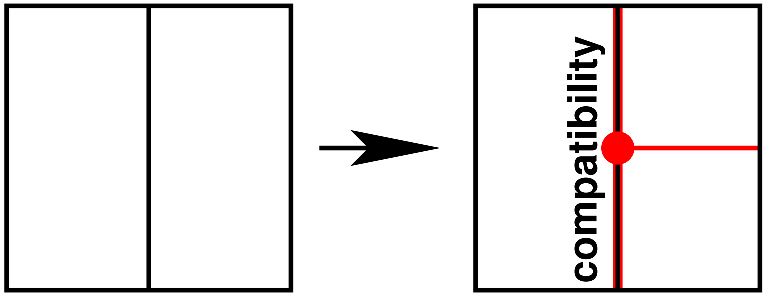


PaLIS (point and line interpolated surfaces)



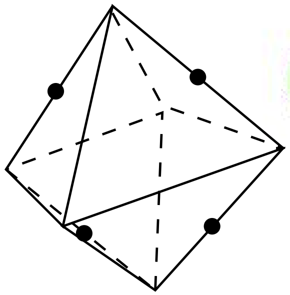


mesh refinements

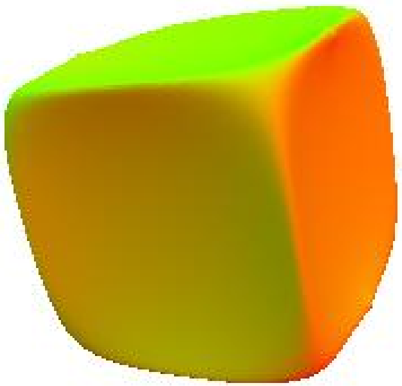


Physical principles, with arbitrary smoothness

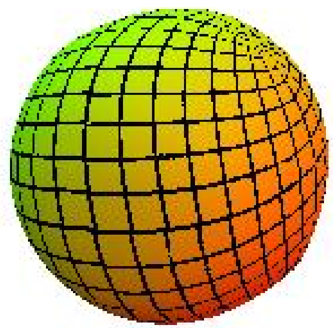
small rigidity

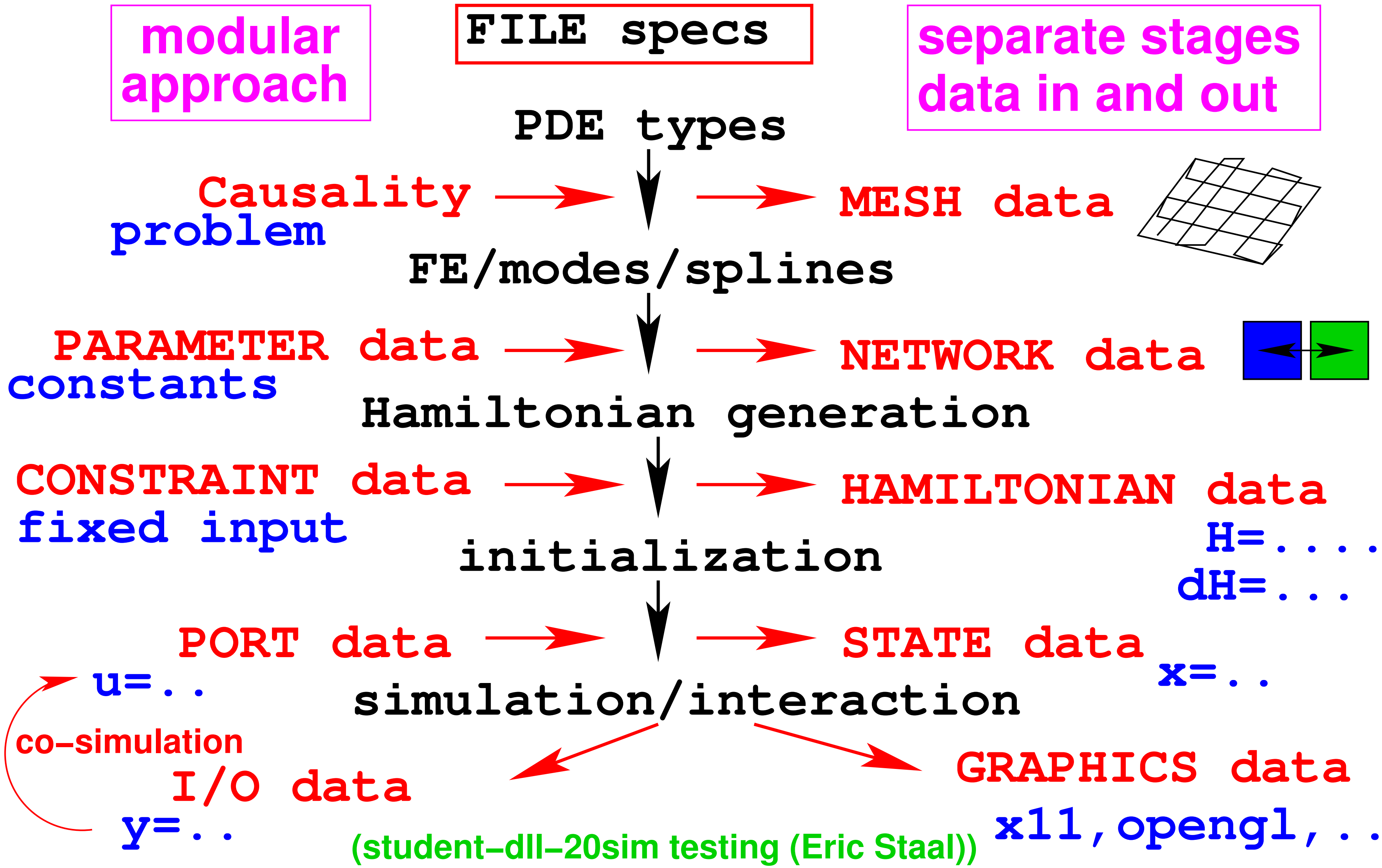


large rigidity



"natural" rigidity





modular approach
FILE specs
separate stages data in and out
PDE types
Causality
problem
MESH data
FE/modes/splines
PARAMETER data
constants
NETWORK data
Hamiltonian generation
CONSTRAINT data
fixed input
HAMILTONIAN data
H=....
dH=...
initialization
PORT data
u=..
STATE data
x=..
simulation/interaction
co-simulation
I/O data
y=..
GRAPHICS data
x11,opengl,..
(student-dll-20sim testing (Eric Staal))

OUTLOOK

* automating Hamiltonian generation

* nonlinear simulation, time integration

* mathematical initial boundary value problem

* case studies (Philips? Reden? Control problems?)

* 20sim integration, simulation software

* writing papers and thesis