

## Happy Birthday!

## Born in 1994, and now a rising junior. Nice work, keep it up.

Now, some memories of one of the CDS founders ...

## Jerry Marsden 1942-2010

... from math through mechanics to control and dynamical systems
BSc U Toronto 1965, PhD Princeton 1968 (Arthur Wightman)
Foundations of Mechanics with Ralph Abraham 1967, 1st/21 books! [2 ${ }^{\text {nd }}$ expanded edn 1978] 1968-95: UCB - Cornell - UCB; 1995-2010: Caltech


Jerry \& Alison, Edinburgh Castle 1976/7

Some more of the books:
Applications of Global Analysis in Math Phys, 1974
Props of Infinite Diml Hamiltonian Systs w P. Chernoff, 1974
The Hopf Bifn \& its Applications w M. McCracken+, 1976
Math Fdns of Elasticity w T Hughes, 1983
Manifolds, Tensor Anal \& Apps w R. Abraham, T. Ratiu, 1988
Lectures on Mechanics, 1992
A Math Intro to Fluid Mechanics w A. Chorin, 1993
Mechanics \& Symmetry w T. Ratiu, 1994
Lagrangian Reduction by Stages w H. Cendra, T. Ratiu, 2001
Hamiltonian Reduction by Stages w Many Others, 2007
Dyn Sys, 3BP, Space Mission Design w Koon, Lo, Ross, 2011
$>400$ papers \& conf. procs.
$48+$ PhDs, 7 MScs, almost 40 postdocs, ??? collaborators, colleagues and friends.

## $\Longrightarrow$ Some of many things Jerry did:

Finite and infinite-dimensional dynamical systems, local and global bifurcations Melnikov methods; ODE, PDE, operator theory; Geometric mechanics, non-canonical Hamiltonian structures and brackets, Hamiltonian and Langrangian reduction theory*; Classical field theories, relativity; Quantum theory; Fluid mechanics, Lagrangian coherent structures; Geometry; Celestial mechanics, space mission design; Numerical methods, symplectic integrators, discrete \& computational mechanics; Optimal control; Apologies for what I forgot ....

c 2008?
*Reduction theory synthesizes the work of Smale, Arnold (and their predecessors ...) into a bundle, with Smale as the base and Arnold as the fiber. - JEM.

## I was fortunate to share in a small part of this:

1975 - corresp. w JEM on applying center manifolds \& bifurcation theory to PDE, Hopf bk ms. 1976 - DS conf in Soton: JEM, J Guckenheimer, N. Kopell, K. Cooke. JEM at HW, begin collab. 1977-80 - NYAS mtgs, bifns \& chaos in "simple" PDEs: Automatica (1978); Arch. Rat. Mech. Anal. (1981). 1981 - Spring at UCB: Melnikov in $n$ dof Hamiltonian systems: Com. Mat. Phys EJ J. Mat. Phys. (1982), Indiana U. Math. J. (1983) ..... JEM at Cornell exp. small separatrix split w J. Scheurle: Cont. Mat. (1988).

PH at Caltech AY 88-89 Appl. Mech. Div., alas, before CDS, and ignorant of Bruce Francis.

## CDS20: Foundations of Dynamics \& Fluid Apps

## Aug 6, 2014

Phil Holmes \& Clancy Rowley, MAE Dept. Prog. in Appl+Comp. Math [Princt Neurosci. Inst.]
$\Longrightarrow$ A very short history of Dynamical Systems:
1880-1995: Poincaré, Birkhoff, Kolmogorov, Anosov, Arnold, Moser, Sinai, Smale, Thom, Takens, Marsden ... . Invariant (center, inertial) manifolds, bifurcations local \& global, homoclinic tangles and chaos, attractors, Focus on limit sets, $t \rightarrow \infty$ asymptotics.
>1995: Computer-aided proofs (Lorenz attr, CHOMP); Finite time behaviors (FTLE); Stochastic dynamics, pullback attractors; Dynamics on networks; Connecting dynamical systems \& control theory; POD -> balanced POD; Data-driven models, Koopman operators; Apologies for all that wish I knew ....

8:30 - Dynamics:
Melvin Leok - Comp geom uncert propagn for Ham systems on a Lie group
Matt West - Atmospheric aerosols, stoch simuln, and data-driven analysis
Shane Ross - Dyn structure \& its uses for insight, discovery, and control
10-Break
10:30 - Fluids: Dennice Gayme, Beverley McKeon, Clancy Rowley, Bassam Bamieh
12 - Lunch, then Apps in Medicine \& Grand Challenges.

