PHY 711 Classical Mechanics and Mathematical Methods
10-10:50 AM MWF Olin 103

Plan for Lecture 37:

Chapter 10 in F & W:

Soliton surface waves

1. **Nonlinear water surface waves – soliton solutions**

22	Wed, 10/17/2012	Chap. 7, 5	Moment of inertia	
	Fri, 10/19/2012		Fall break	
23	Mon, 10/22/2012	Chap. 5	Rigid body rotation	#16
24	Wed, 10/24/2012	Chap. 5	Rigid body rotation	#17
25	Fri, 10/26/2012	Chap. 5	Rigid body rotation	#18
26	Mon, 10/29/2012	Chap. 8	Waves in elastic membranes	#19
27	Wed, 10/31/2012	Chap. 9	Introduction to hydrodynamics	
28	Fri, 11/01/2012	Chap. 9	Introduction to hydrodynamics	
29	Mon, 11/05/2012	Chap. 9	Introduction to hydrodynamics	#20
30	Wed, 11/07/2012	Chap. 9	Sound waves	
31	Fri, 11/09/2012	Chap. 9	Linear sound waves	#21
32	Mon, 11/12/2012	Chap. 9	Green's function for linear sound	
33	Wed, 11/14/2012	Chap. 9	Non-linear sound	
34	Fri, 11/16/2012	Chap. 9	Non-linear sound	Take Home Exam
35	Mon, 11/19/2012	Chap. 10	Surface waves	Take Home Exam
	Wed, 11/21/2012		*Thanksgiving Holiday*	
	Fri, 11/23/2012		*Thanksgiving Holiday*	
36	Mon, 11/26/2012	Chap. 10	Surface waves	Exam due
37	Wed, 11/28/2012	Chap. 10	Surface waves	
38	Fri, 11/30/2012	Chap. 10	Surface waves	
39	Mon, 12/03/2012		Student presentations I	
40	Wed, 12/05/2012		Student presentations II	

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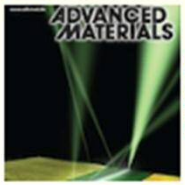
News

Grad Student Chen Liu Wins Young Investigator Award

Physics Alumni Dr. Yuan Li ('12) Wins Environmental Research Award

Physics Team to Lead Search for Drug Discovery



Article by Prof. Jurchescu and grad student Jeremy Ward featured on the cover of Advanced Materials

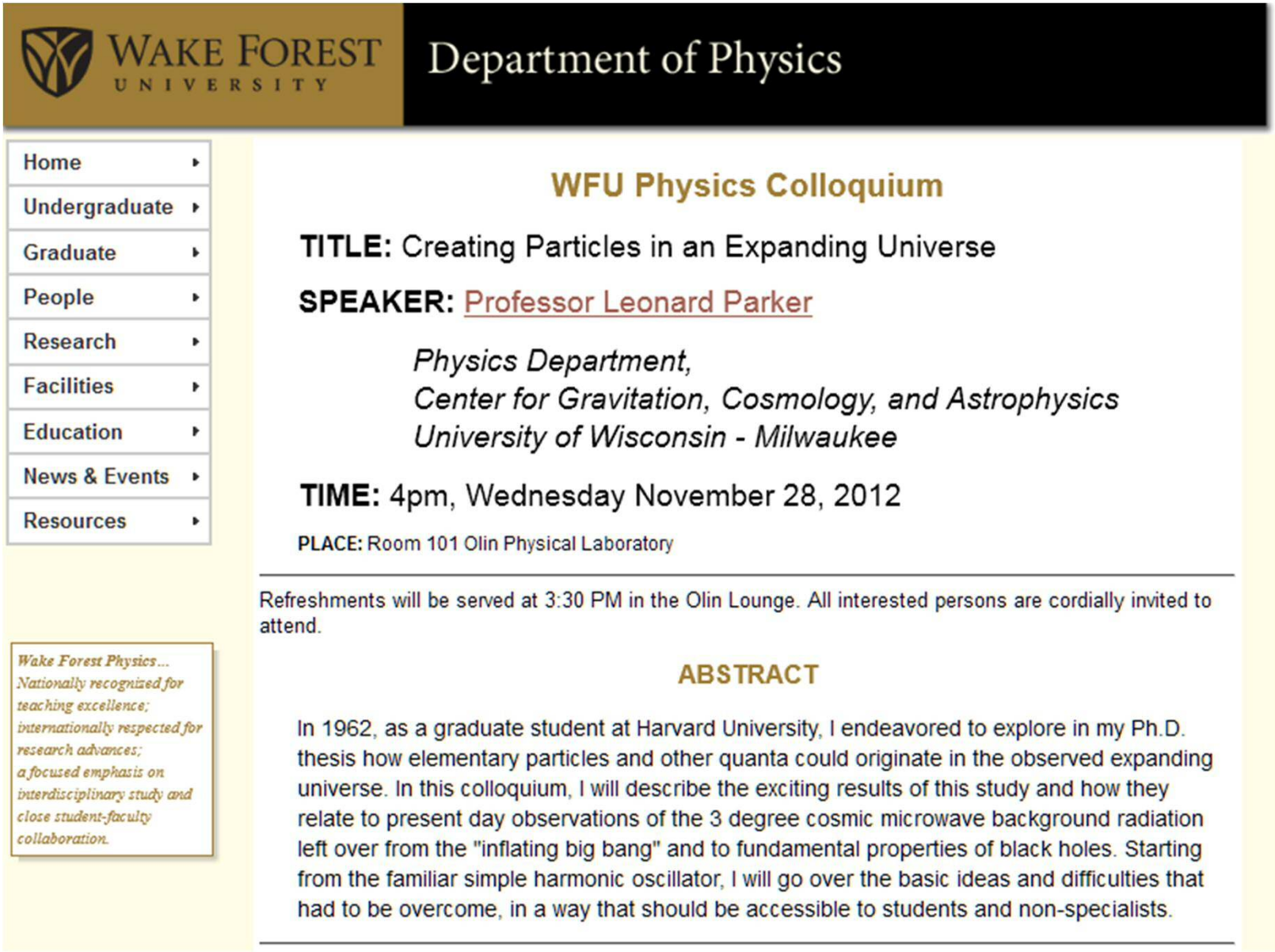
Workshop for Middle School Teachers Organized by Prof. Cho is Featured in Mashable, Huffington Post, and Fox 8 News

Events

Wed Nov 28, 2012
Professor Leonard Parker
University of Wisconsin, Milwaukee
4:00 PM in Olin 101
Refreshments at 3:30 in Lobby

Wed. Dec. 5, 2012
Dr. Pablo Caneda
WFU
Binding and diffusion of small molecules in metal organic frameworks
4:00 PM in Olin 101
Refreshments at 3:30 in Lobby

Profiles in Physics



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WFU Physics Colloquium

TITLE: Creating Particles in an Expanding Universe

SPEAKER: Professor Leonard Parker

Physics Department,
Center for Gravitation, Cosmology, and Astrophysics
University of Wisconsin - Milwaukee

TIME: 4pm, Wednesday November 28, 2012

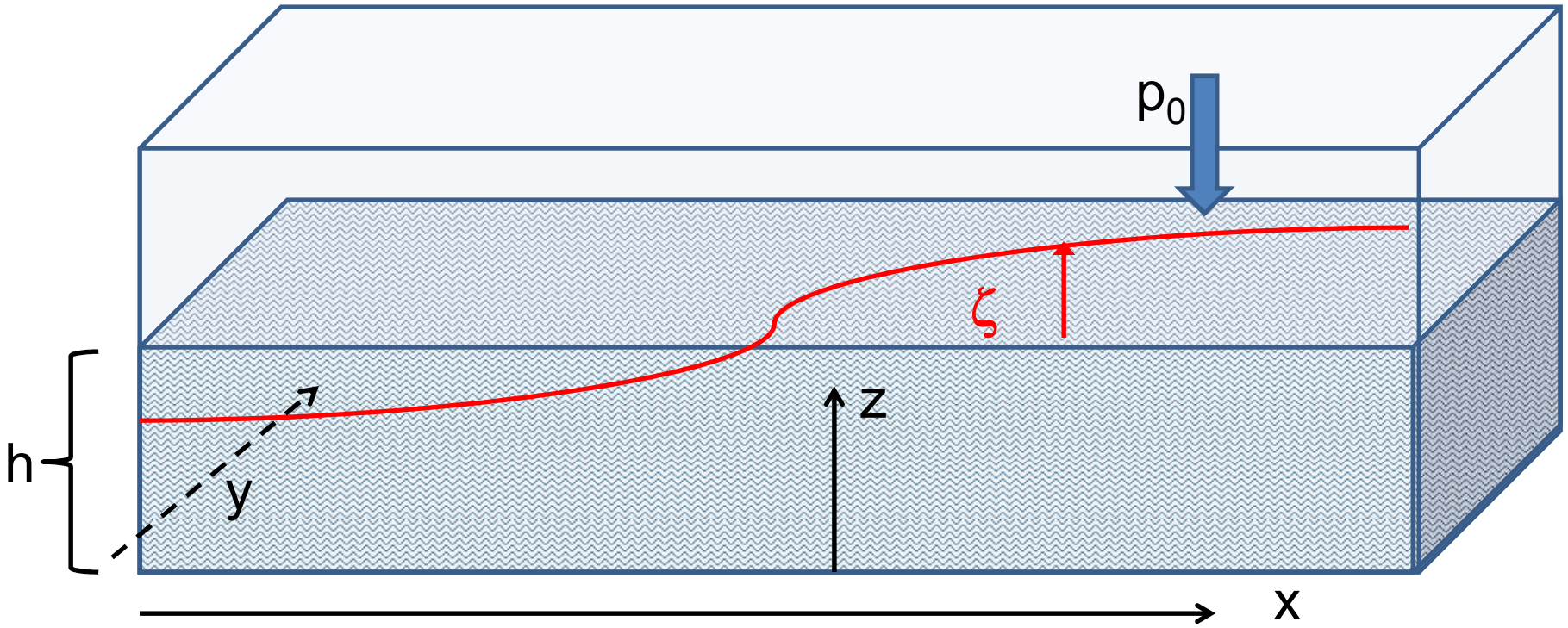
PLACE: Room 101 Olin Physical Laboratory

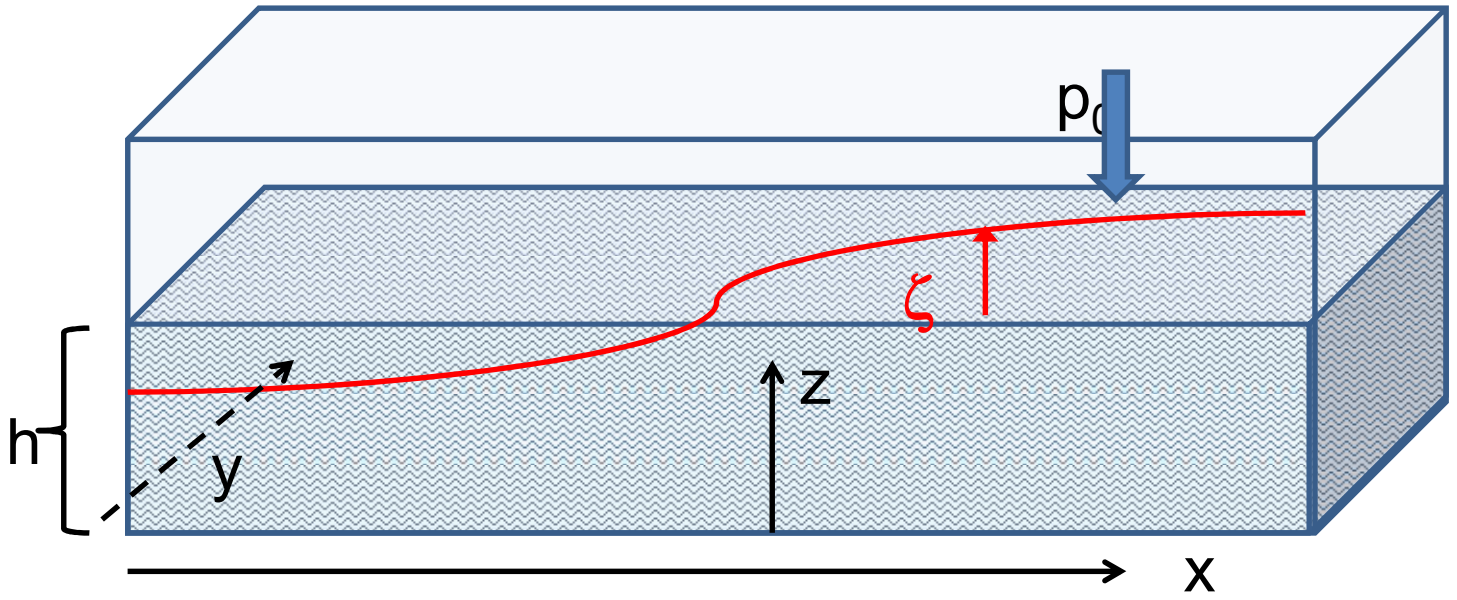
Refreshments will be served at 3:30 PM in the Olin Lounge. All interested persons are cordially invited to attend.

ABSTRACT

In 1962, as a graduate student at Harvard University, I endeavored to explore in my Ph.D. thesis how elementary particles and other quanta could originate in the observed expanding universe. In this colloquium, I will describe the exciting results of this study and how they relate to present day observations of the 3 degree cosmic microwave background radiation left over from the "inflating big bang" and to fundamental properties of black holes. Starting from the familiar simple harmonic oscillator, I will go over the basic ideas and difficulties that had to be overcome, in a way that should be accessible to students and non-specialists.

Consider a container of water with average height h and surface h+ζ(x,y,t) (slightly different notation than last time):





Within fluid : $0 \le z \le h + \zeta$

$$-\frac{\partial \Phi}{\partial t} + \tfrac{1}{2} v^2 + g(z-h) = \text{constant}$$ (We have absorbed p_0 in our constant.)

$$-\nabla^2 \Phi = 0$$

At surface : $z = h + \zeta$ with $\zeta = \zeta(x, y, t)$

$$\frac{d\zeta}{dt} = \frac{\partial \zeta}{\partial t} + v_x \frac{\partial \zeta}{\partial x} + v_y \frac{\partial \zeta}{\partial y}$$ where $v_{x,y} = v_{x,y}(x, y, h + \zeta, t)$

Convenient assumptions : trivial y dependence

express problem in terms of $\Phi(x,z,t)$

and $\zeta(x,t)$

Bernoulli's equation at water surface

$$-\frac{\partial\Phi(x,z,t)}{\partial t}+\frac{1}{2}\left[\left(\frac{\partial\Phi(x,z,t)}{\partial x}\right)^2+\left(\frac{\partial\Phi(x,z,t)}{\partial z}\right)^2\right]\Bigg|_{z=h+\zeta}+g\zeta(x,t)=0$$

Consistent vertical velocity at water surface

$$v_z(x,z,t)\big|_{z=h+\zeta}=\frac{d\zeta}{dt}=\mathbf{v}\cdot\nabla\zeta+\frac{\partial\zeta}{\partial t}.$$

$$-\frac{\partial\Phi(x,z,t)}{\partial z}+\frac{\partial\Phi(x,z,t)}{\partial x}\frac{\partial\zeta(x,t)}{\partial x}-\frac{\partial\zeta(x,t)}{\partial t}\Bigg|_{z=h+\zeta}=0$$

Boundary condition at z=0

Zero vertical velocity at bottom of tank

$$\frac{\partial \Phi(x,0,t)}{\partial z} = 0.$$

Taylor's expansion about $z = 0$

$$\Phi(x,z,t) \approx \Phi(x,0,t) + z\frac{\partial \Phi}{\partial z}(x,0,t) + \frac{z^2}{2}\frac{\partial^2 \Phi}{\partial z^2}(x,0,t) + \frac{z^3}{3!}\frac{\partial^3 \Phi}{\partial z^3}(x,0,t) + \frac{z^4}{4!}\frac{\partial^4 \Phi}{\partial z^4}(x,0,t)\cdots$$

$$\Rightarrow \Phi(x,z,t) \approx \Phi(x,0,t) + \frac{z^2}{2}\frac{\partial^2 \Phi(x,0,t)}{\partial z^2} + \frac{z^4}{4!}\frac{\partial^4 \Phi(x,0,t)}{\partial z^4}....$$

$$\Phi(x,z,t) \approx \Phi(x,0,t) + \frac{z^2}{2}\frac{\partial^2\Phi(x,0,t)}{\partial z^2} + \frac{z^4}{4!}\frac{\partial^4\Phi(x,0,t)}{\partial z^4} \ldots.$$

$$\text{From Laplace equation : } \frac{\partial^2\Phi(x,z,t)}{\partial x^2} + \frac{\partial^2\Phi(x,z,t)}{\partial z^2} = 0$$

Modified Taylor's expansion

$$\Phi(x,z,t) \approx \Phi(x,0,t) - \frac{z^2}{2}\frac{\partial^2\Phi}{\partial x^2}(x,0,t) + \frac{z^4}{4!}\frac{\partial^4\Phi}{\partial x^4}(x,0,t) \cdots$$

Bernoulli's equation at water surface

$$-\frac{\partial\Phi(x,z,t)}{\partial t} + \frac{1}{2}\left[\left(\frac{\partial\Phi(x,z,t)}{\partial x}\right)^2 + \left(\frac{\partial\Phi(x,z,t)}{\partial z}\right)^2\right]\Bigg|_{z=h+\zeta} + g\zeta(x,t) = 0$$