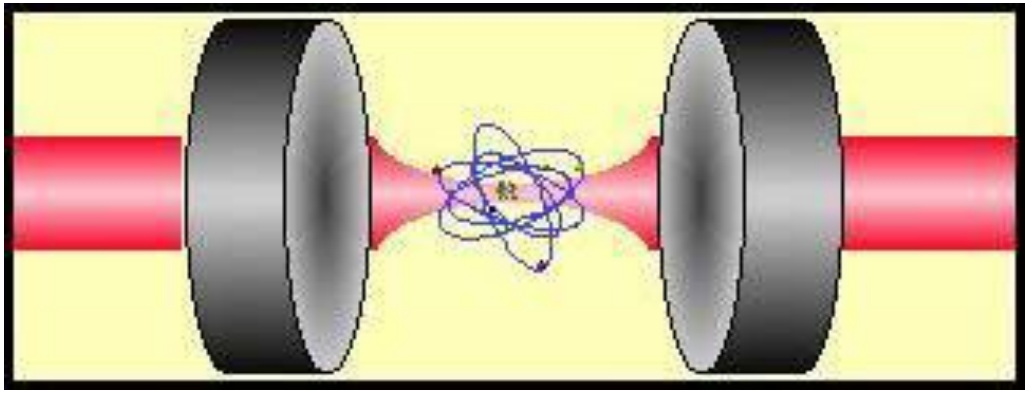
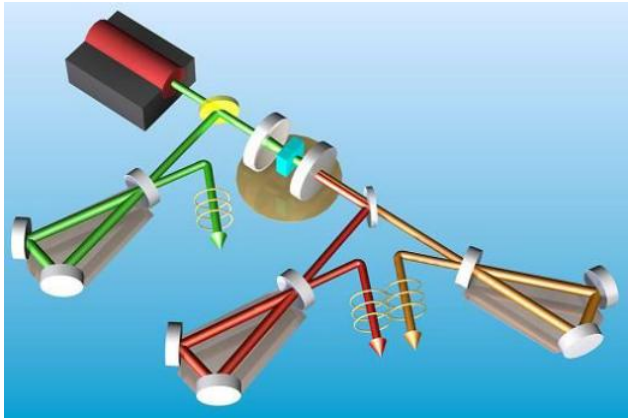


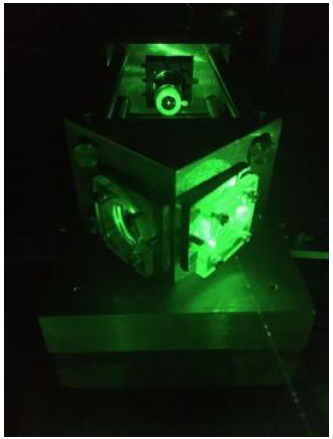
LMCAL at USP

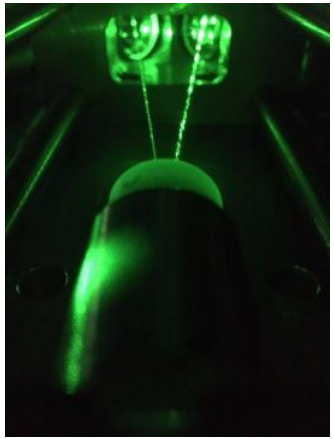
Ricky Elwell

Quantum Optics

- Entangling light beams
- “Squeezing” Light
  - Crystals
  - Atomic Gases
  - Silicon chips
- Designing cavities
  - Working with Gaussian beams

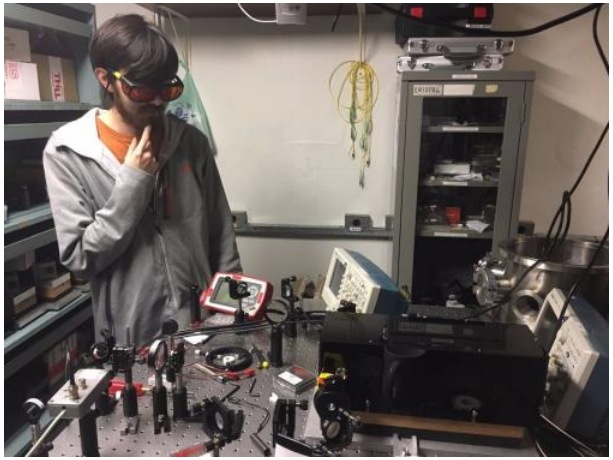






Day-to-Day

- Coffee & Memes
- Clean mirrors
- Turn on laser and pray
- Coffee
- Mode matching cavity
- Analyzing noise spectra
- Coffee
- Plot data
- Coffee w/ coworkers



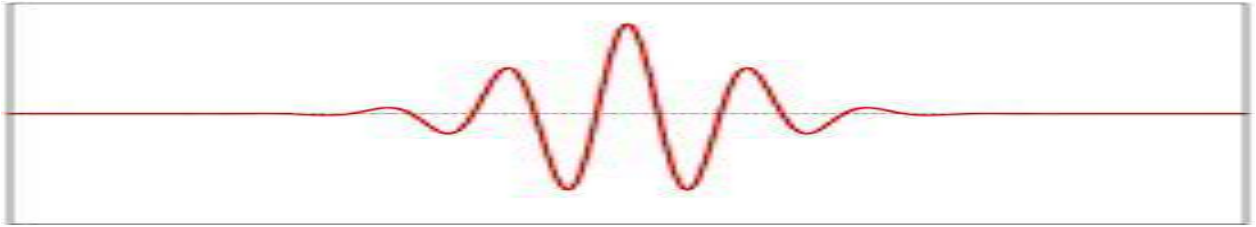
Besides work

- São Paulo is massive
- Interesting food
- Forro
- Art & music
- Beaches of Brasil
- Really weird legends
  - Dolphin man
  - Uphill magnetism

Thank you

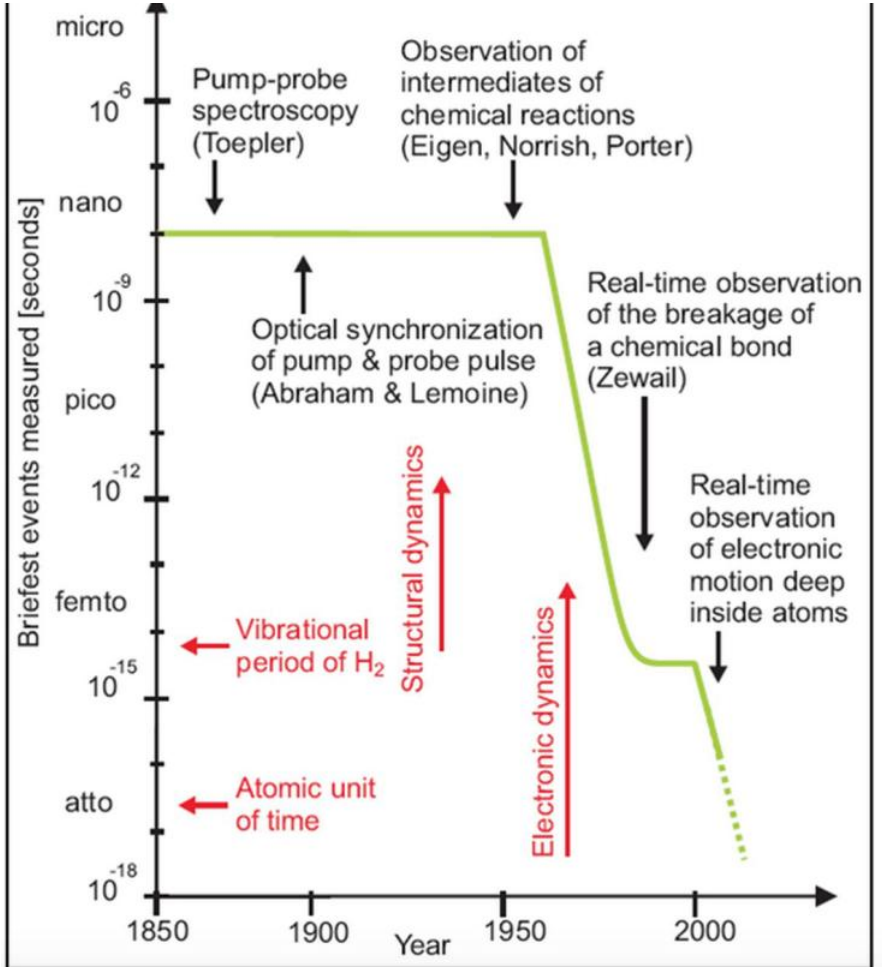
Attosecond Science

An investigation into the feasibility of using an electron bunch's space charge field as an ultrafast pulse



Margaret Doyle

SLAC
NATIONAL ACCELERATOR LABORATORY



Relativistic Nonlinear Thomson Scattering: Toward Intense Attosecond Pulse

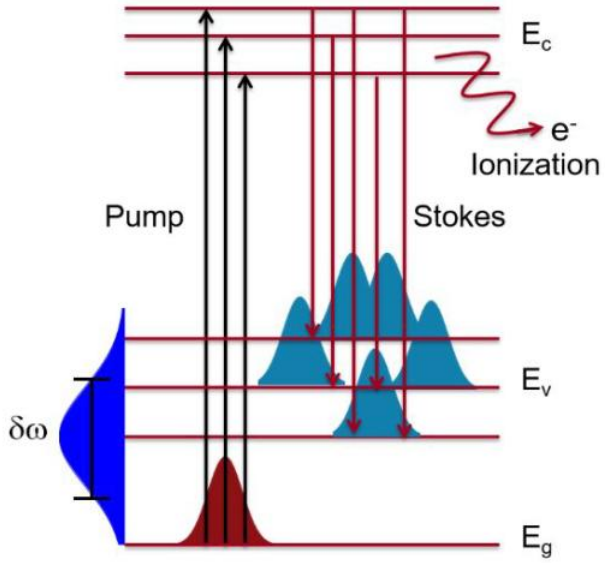
By Kitae Lee, Sang-Young Chung, and Dong-Eon Kim

DOI: 10.5772/7964

1×10^{-18} seconds

2 as : 1 sec :: 1 sec : Age of the Universe

Attosecond Science: Impulsive Stimulated Electronic Raman Redistribution



Needs two things:

high intensity
broad bandwidth

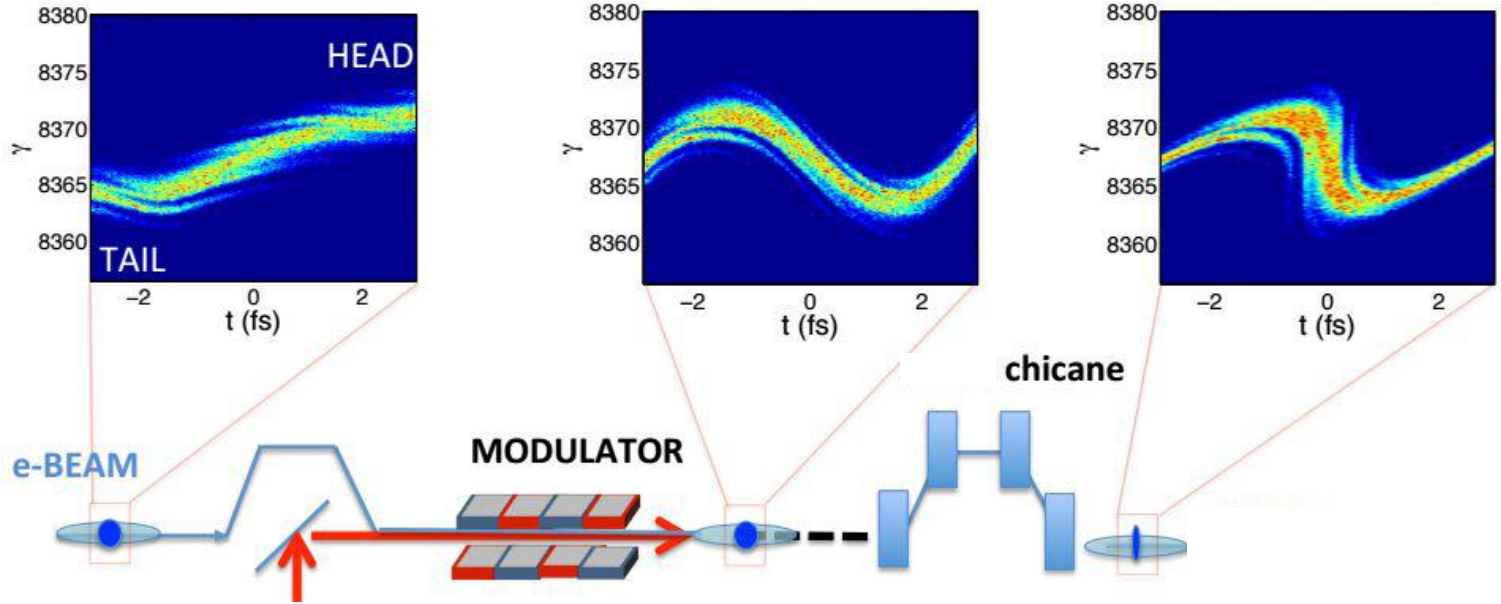
The attosecond regime of impulsive stimulated electronic Raman excitation

Matthew R. Ware,[1,2] Philip H. Bucksbaum,[1,2,3] James P. Cryan,[2] and Daniel J. Haxton[4]

[1] *Department of Physics, Stanford University, Stanford, California 94305, USA*
[2] *Stanford PULSE Institute, SLAC National Accelerator Laboratory, Menlo Park, CA 94025, USA*
[3] *Department of Applied Physics, Stanford University, Stanford, California 94305, USA*
[4] *Department of Physics, University of California, Berkeley, CA 94720, USA**

(Dated: October 6, 2016)

New Approach: Use transverse space-charge field from electron bunch



Laser interacts with electrons (red line)

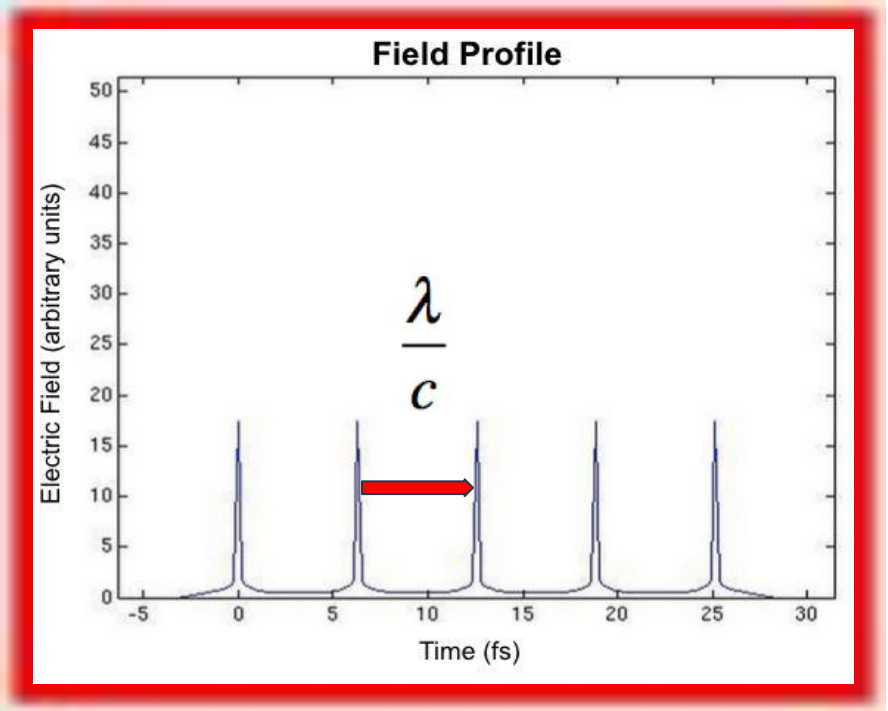
The Resulting Electric Field Profile

Can filter the low frequency components with a metal foil

Want gaussian edge at beginning and end of bunch so you don't have spurious frequency components

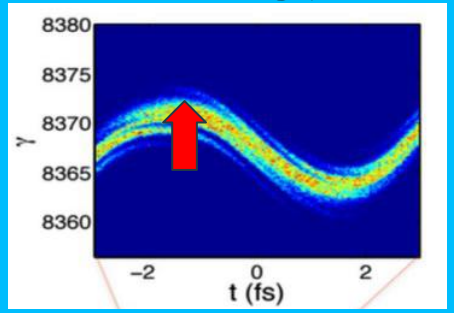
$$E_r = \frac{I(t)Z_0}{2\pi r}$$

I = 10 kA
r = 1 um
E~1 TV/m
Intensity ~2 x 10^17 W/cm^2

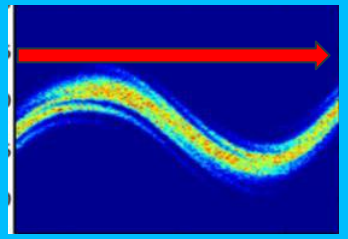


3 Parameters Changed:

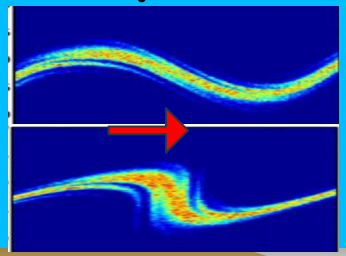
-***Modulation depth*** (ratio of energy modulation to energy spread of beam)



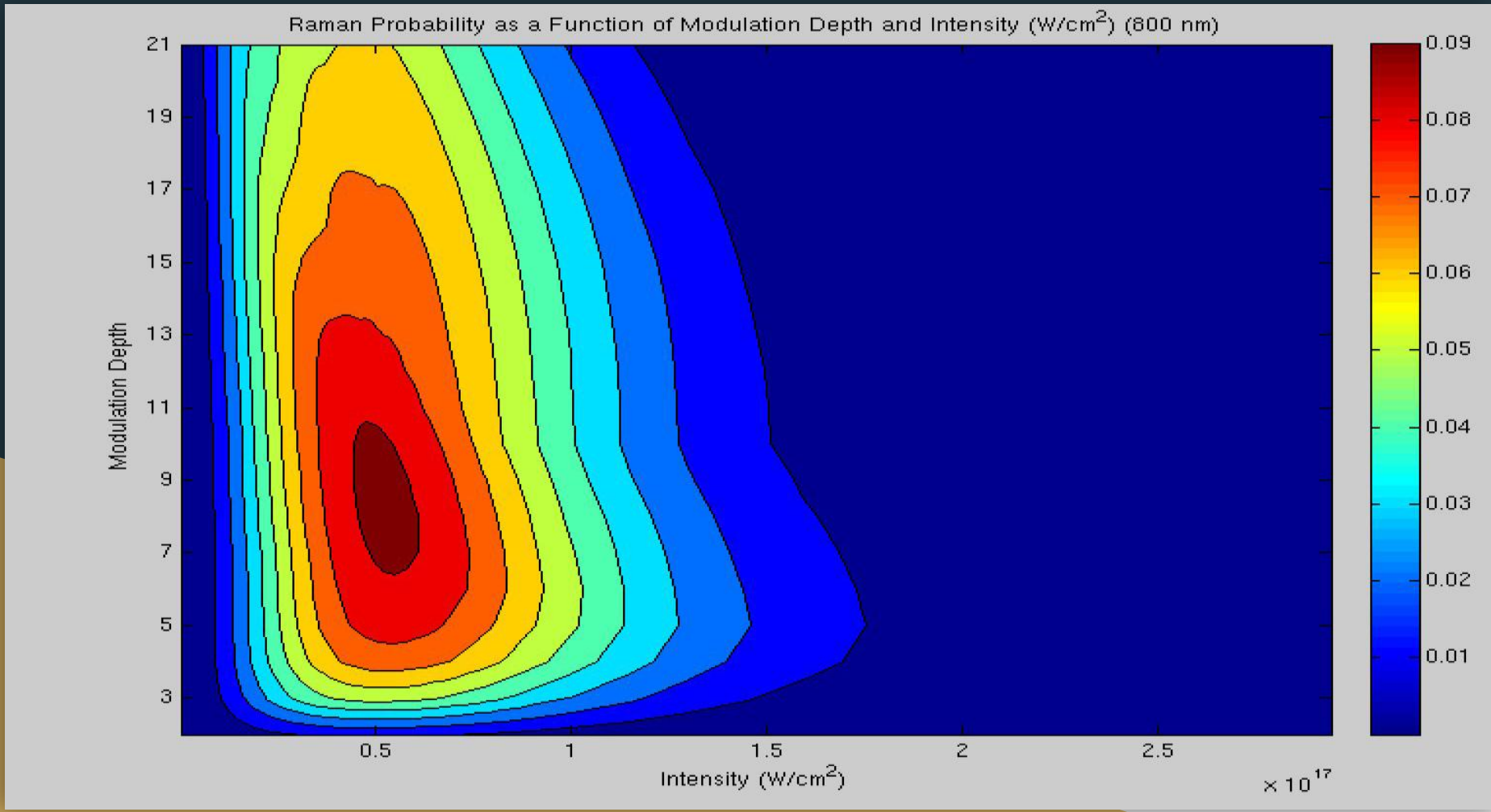
-**Wavelength** (800 nm, 1600 nm, 2400 nm)

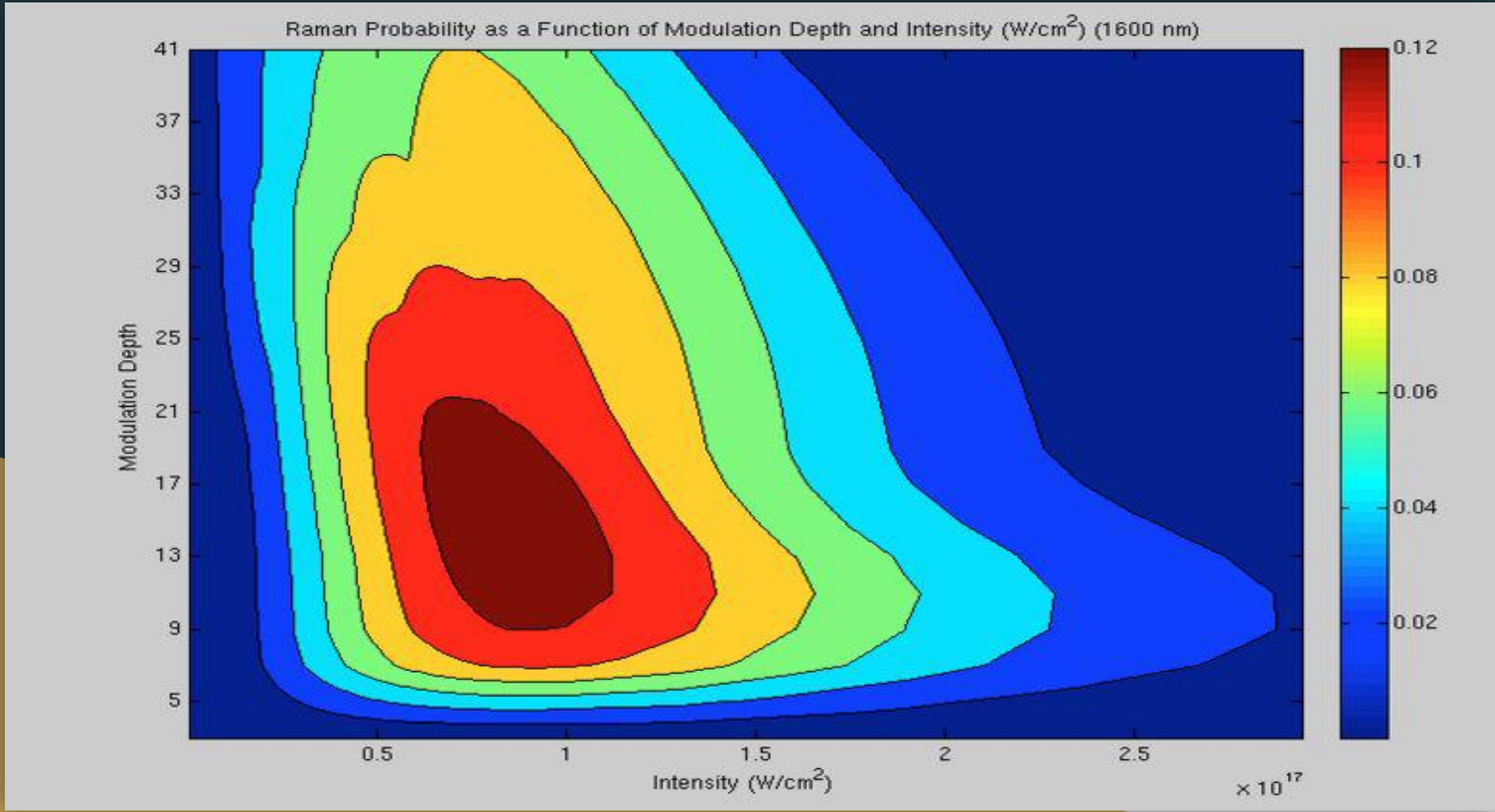


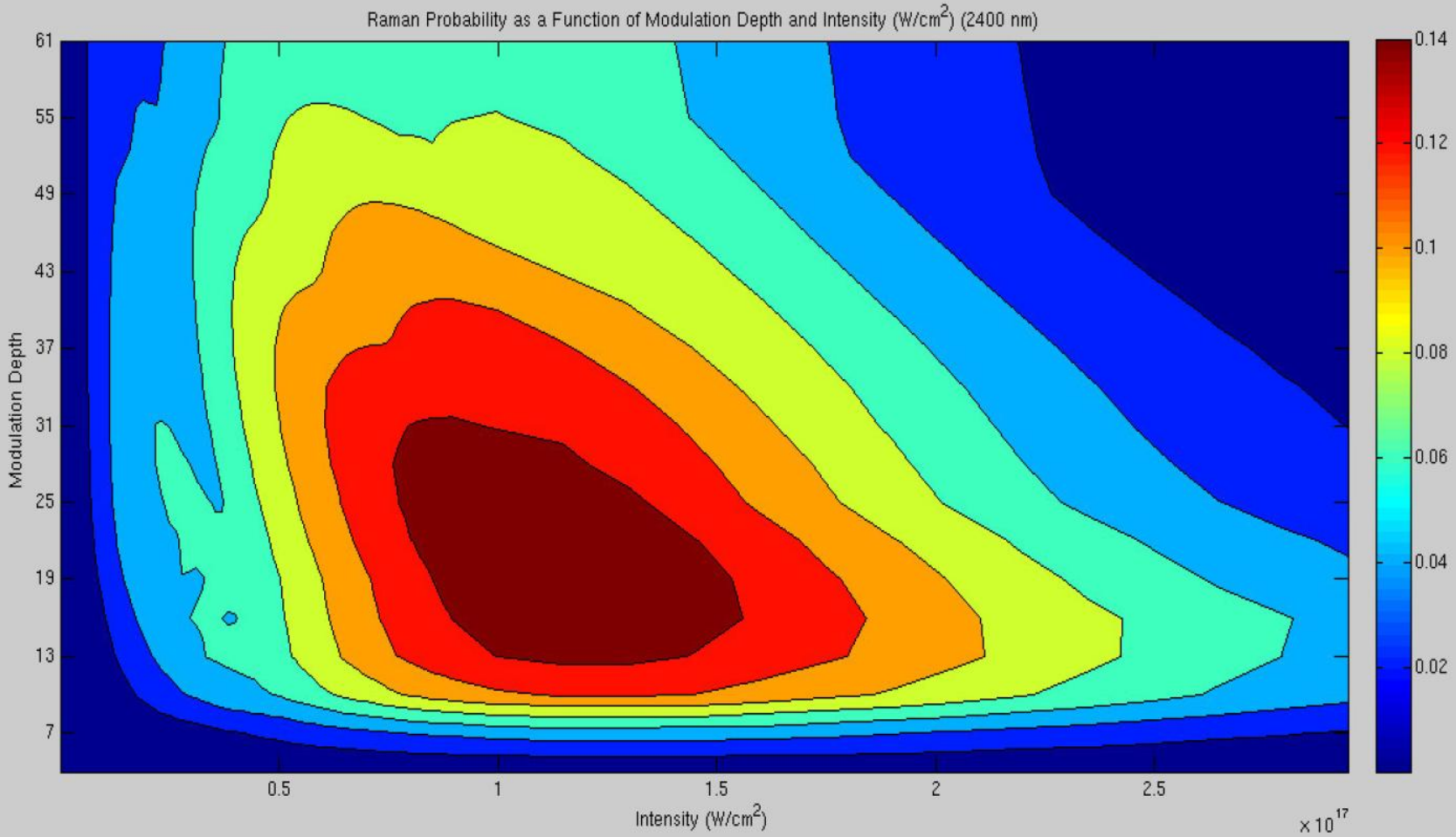
-**max displacement of electrons from initial position**, in units of the laser phase



$$p = \frac{dist * 2 * \pi}{\lambda}$$


Raman Probability as a Function of Modulation Depth and Intensity (W/cm^2) (800 nm)
Modulation Depth
21
19
17
15
13
11
9
7
5
3
0.5
1
1.5
2
2.5
Intensity (W/cm^2)
$\times 10^{17}$
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01


Raman Probability as a Function of Modulation Depth and Intensity (W/cm^2) (1600 nm)
Modulation Depth
41
37
33
29
25
21
17
13
9
5
0.5
1
1.5
2
2.5
Intensity (W/cm^2)
× 10^{17}
0.12
0.1
0.08
0.06
0.04
0.02

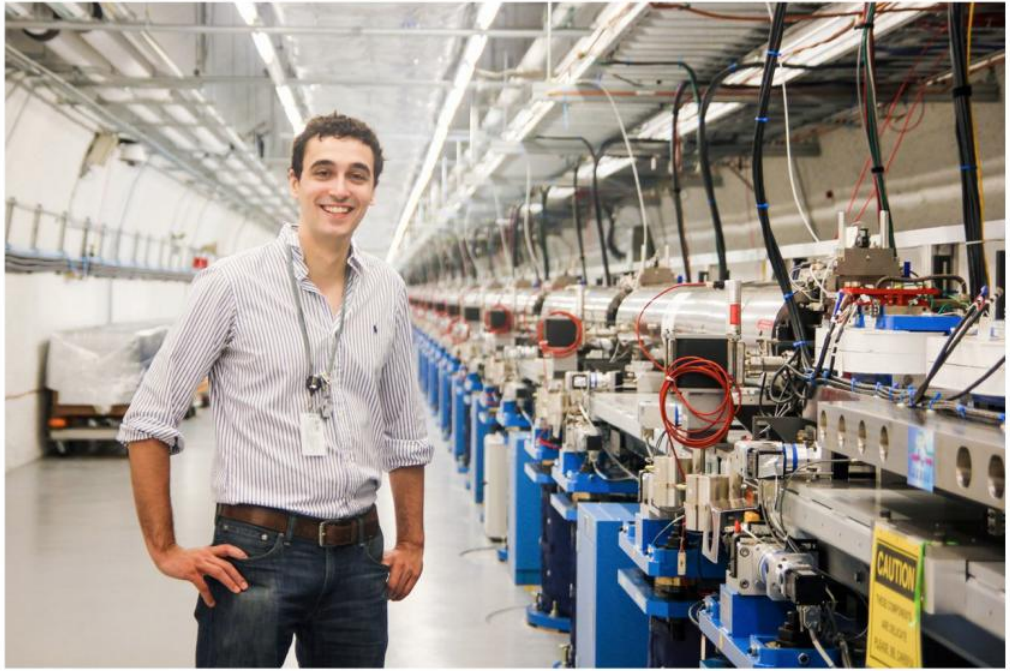

Raman Probability as a Function of Modulation Depth and Intensity (W/cm^2) (2400 nm)
Modulation Depth
61
55
49
43
37
31
25
19
13
7
0.5
1
1.5
2
2.5
Intensity (W/cm^2)
× 10^{17}
0.14
0.12
0.1
0.08
0.06
0.04
0.02

Raman probability of nearly 14%

Required field intensity ~ 0.5 TV/m (achievable with existing laser and accelerator technology)

GREAT! Because 10% is a GOOD excitation fraction for any experiment

Looking Forward



SLAC accelerator physicist Agostino Marinelli, shown here in the LCLS Undulator Hall, has been named 2014 recipient of the Frank Sacherer Prize by the European Physical Society in recognition of his considerable contributions to free-electron laser science at an early stage in his career.

Dr. James Cryan

Cool Mentors


LICK OBSERVATORY
UNIVERSITY OF CALIFORNIA

Thank you

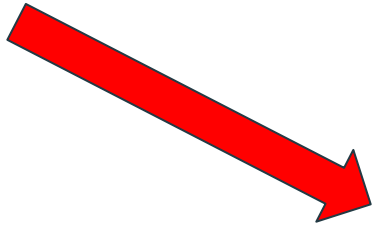
Heisenberg uncertainty relationship

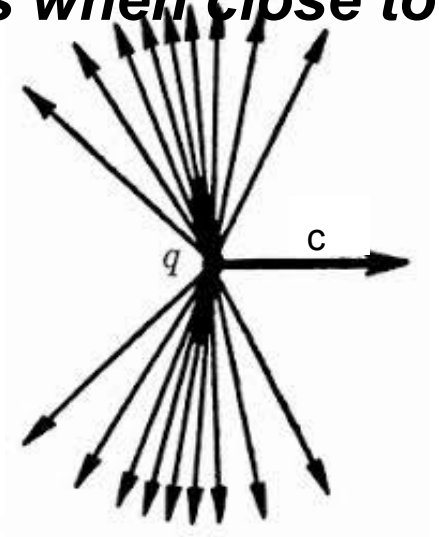
$$\Delta E \, \Delta t \geq \frac{1}{2} \hbar$$

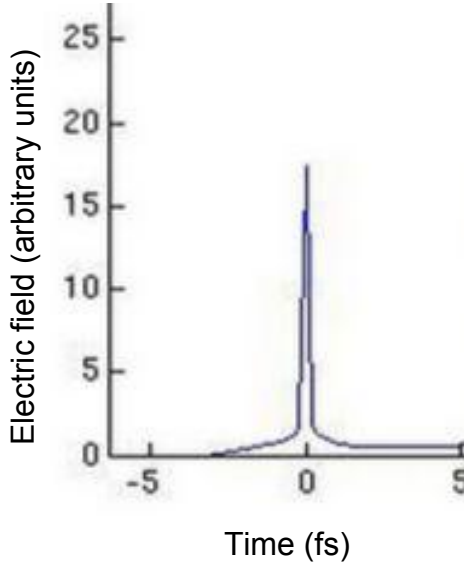
Extra slide:

field distorts when close to relativistic electron

Really fast e-field meter





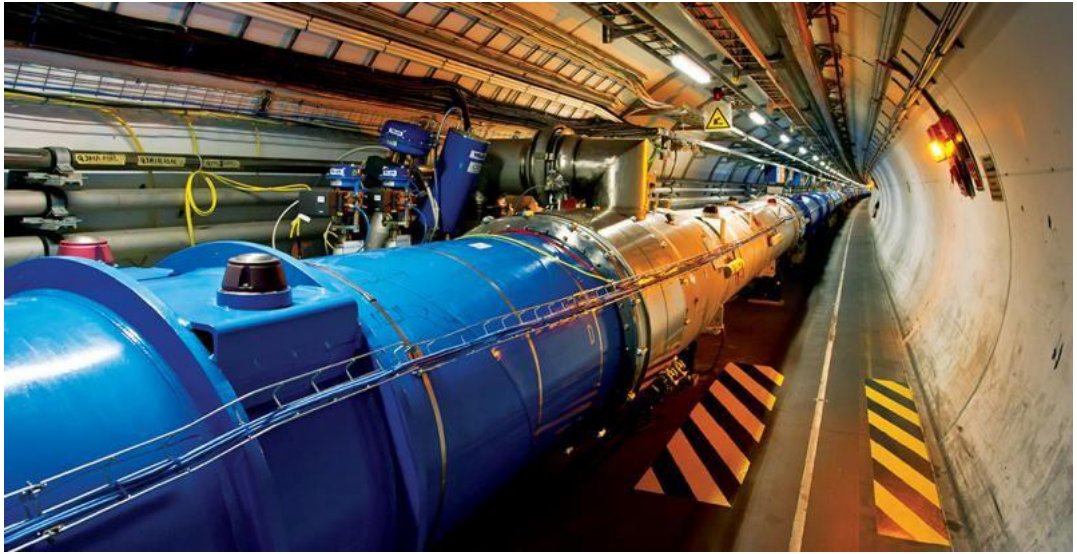


Black Holes at the LHC

September 8th, 2017

Gage DeZoort

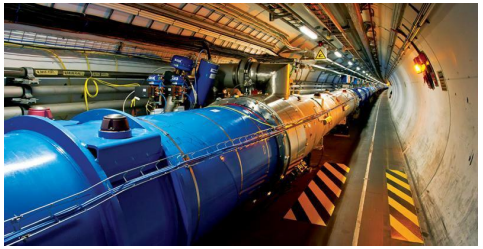

… sitting 100 meters below the Swiss/French border
LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
SUISSE
FRANCE
CMS
ALICE
LHC 27 km

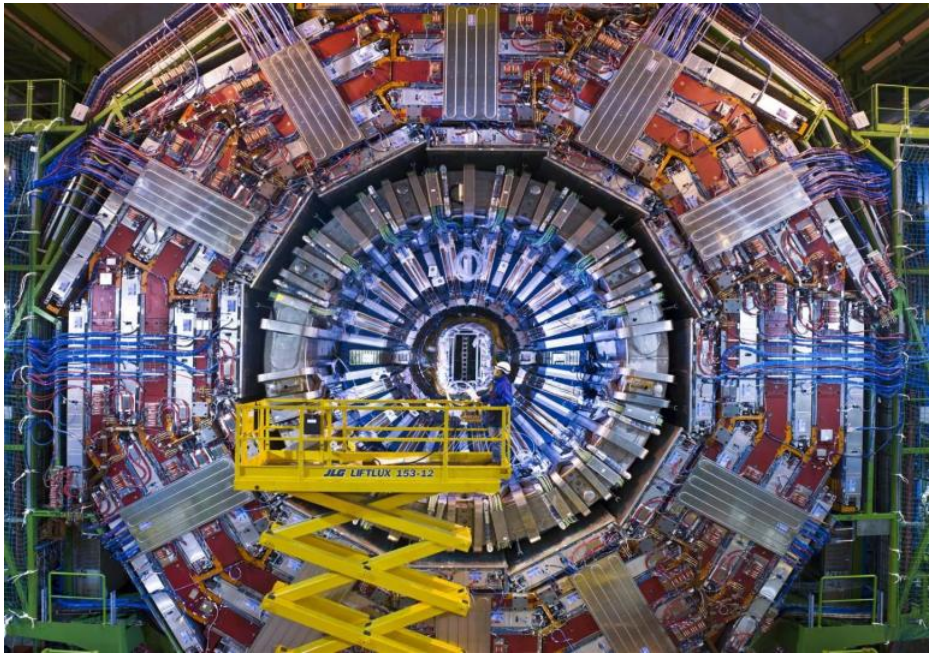


Protons accelerated to ~0.99999999 times the speed of light

Circulating beams reach ~6.5 TeV each

Protons circulate 11245 times per second

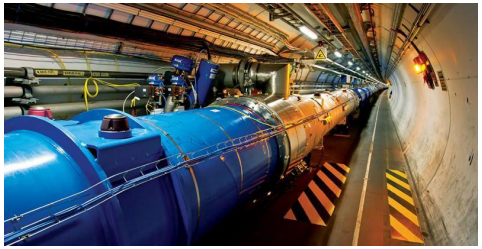


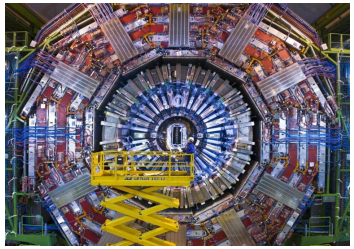


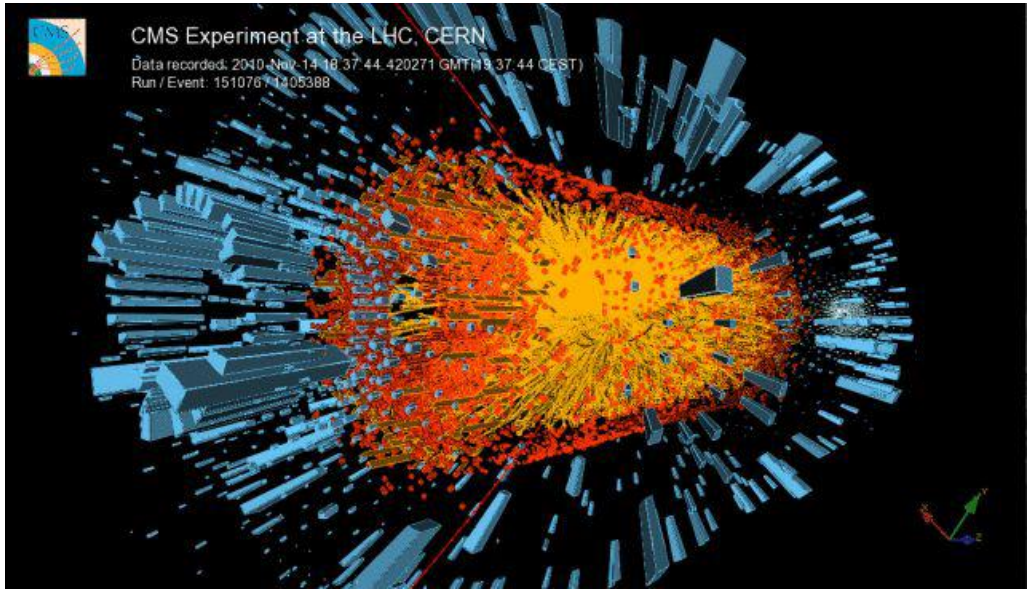
Protons beams are made to collide at ~13 TeV

Collisions occur inside of detectors such as CMS

~1 billion collisions per second



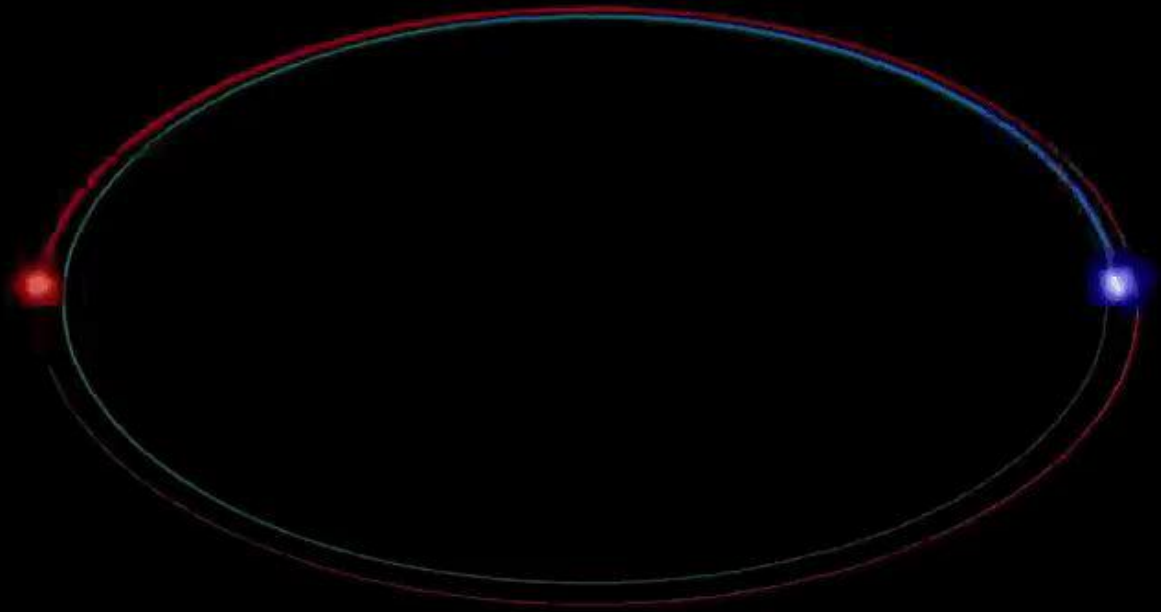


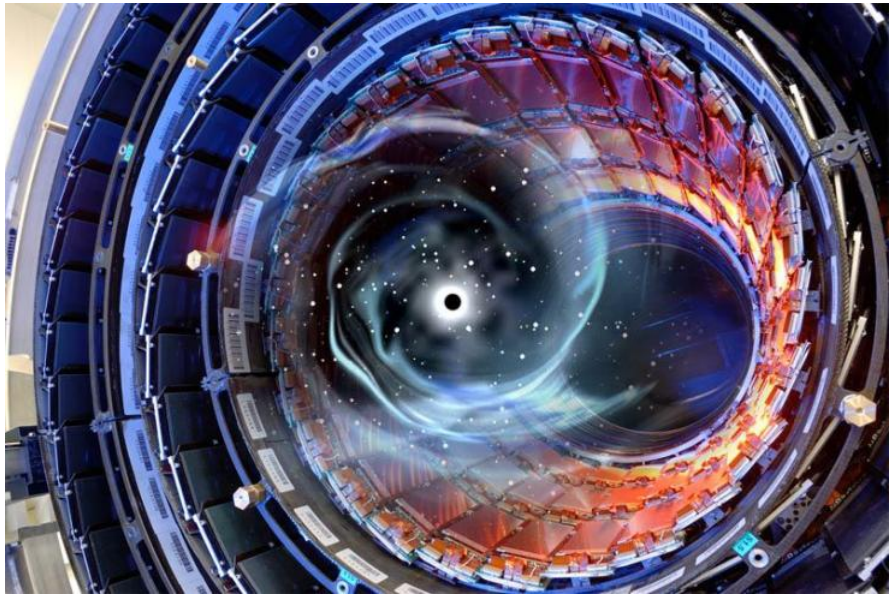


Detectors take pictures of these collisions

Sprays of particles give us information about the physics at work

We can discover new particles by looking at collision products





Microscopic black holes are allowed by the standard model!

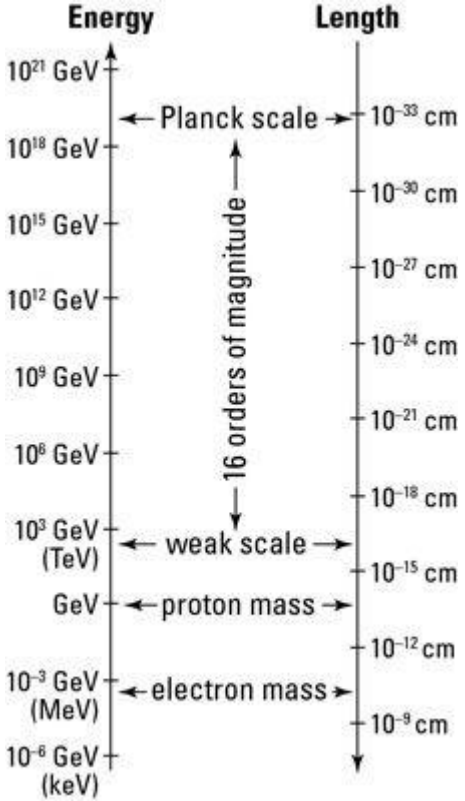
A Hierarchy Problem

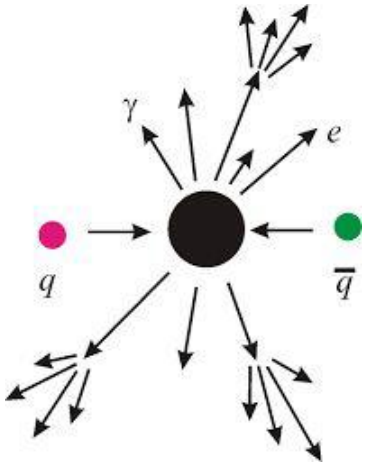
- Hierarchy problem: $M_{Pl} >>> M_{EW}$
- Various solutions
  - ADD Model --> *n* large extra dimensions
  - RS1 Model --> single extra warped spatial dimension
  - SBs --> string balls, might transition to BHs
- Each model predicts an adjusted M_{Pl}:

$$M_D = \frac{1}{r}\left(\frac{rM_{Pl}}{\sqrt{8\pi}}\right)^{\frac{2}{n+2}}$$ (ADD Model)

$$M_D = \frac{M_{Pl}}{\sqrt{8\pi}} e^{-\pi kr}$$ (RS1 Model)

M_D ~ 1TeV



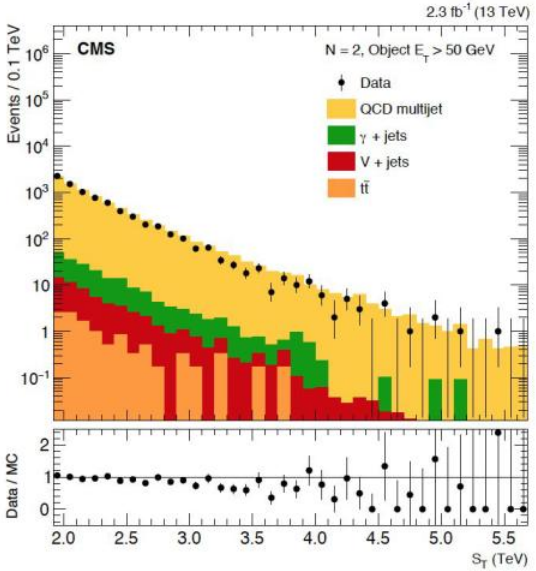


$$R_S = \frac{1}{\sqrt{\pi} M_D} \left[\frac{M_{BH}}{M_D} \left(\frac{8\Gamma(\frac{n+3}{2})}{n+2} \right) \right]^{\frac{1}{n+1}}$$

BH produced when $M_{pp} > M_D$

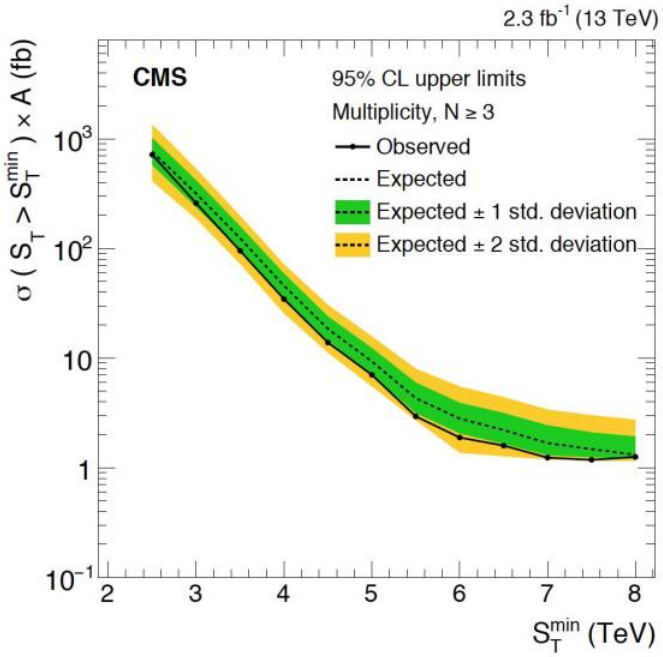
Observing Black Holes

- Variable of interest: $S_{\mathrm{T}} = \left(\sum_{i=1}^{N} E_{\mathrm{T},i} \right) + E_{\mathrm{T}}^{\mathrm{miss}}$
  - Scalar sum of jet, photon, lepton, and missing E_T
  - *N* is the final state multiplicity
- Our main backgrounds are dominated by QCD multijet
- Empirically, S_T is *multiplicity invariant*
  - ➔ bkgd estimation

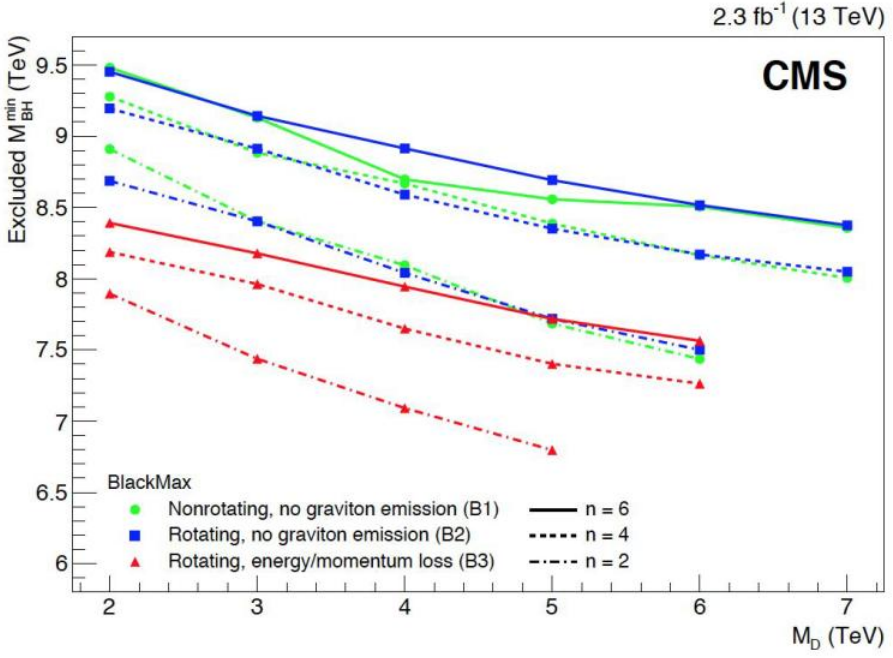


QCD multijet background dominates

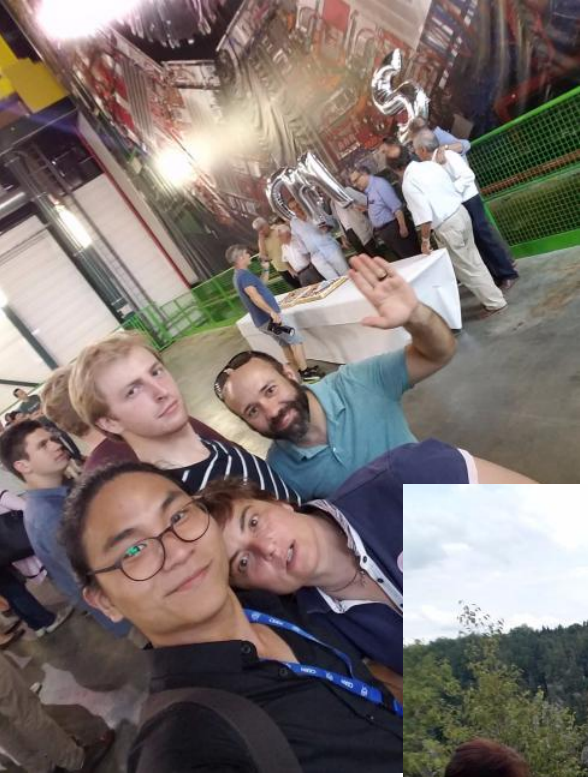
Limiting Black Hole Production



Model **Independent** Search



Model **Dependent** Search



Modeling a New Method for X-Ray Crystallography

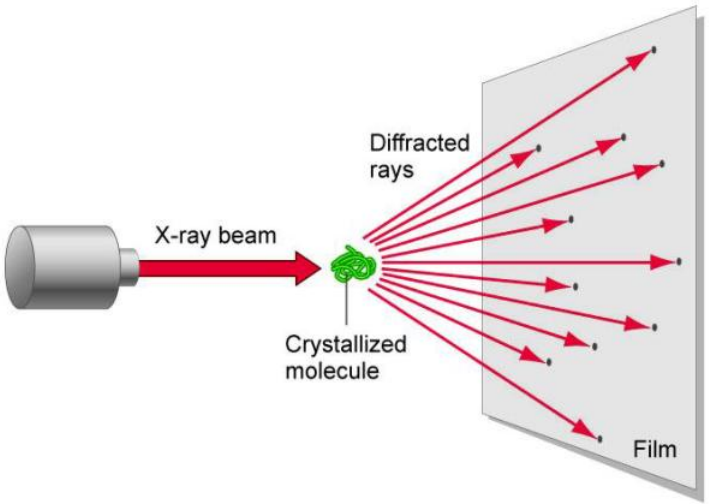
Victoria Kovalchuk

How I Got this Opportunity

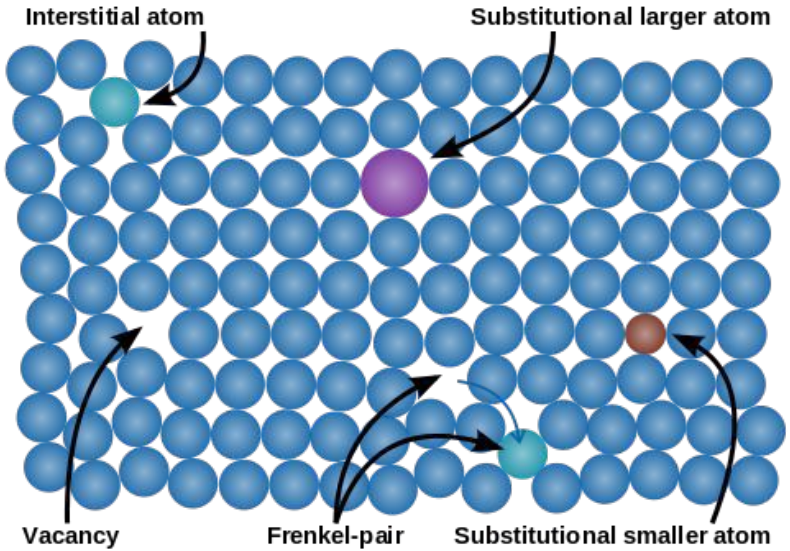
- Just looked around
- The more the merrier
- Cornell Laboratory for Accelerator-Based Science and Education (CLASSE)

X-Ray Crystallography

- A technique to determine the structure of a crystal
- Starts with X-ray diffraction
- Cornell uses its synchrotron CHESS to produce X-rays and



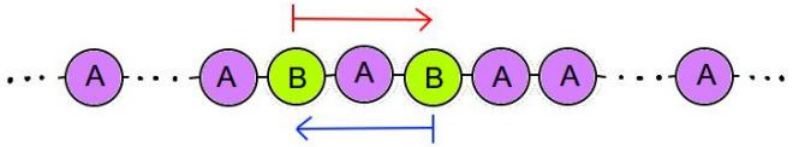
Correlated Disorder

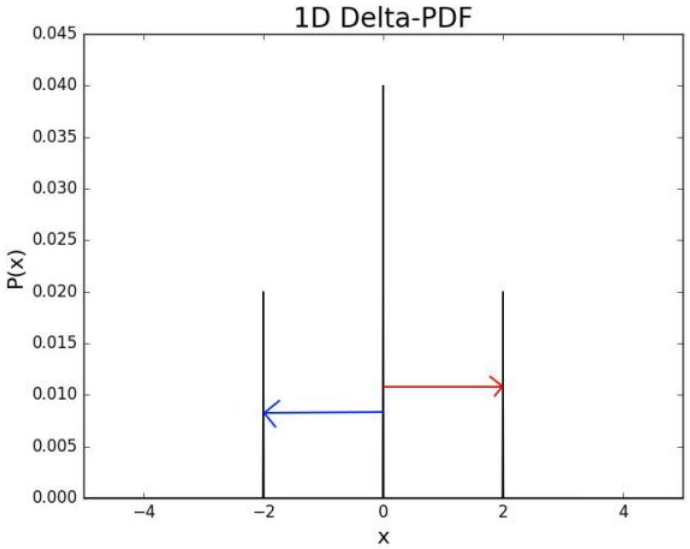


- A perfect crystal consists of a unit cell that that is translated to create a lattice that extends in all directions
- X-ray crystallography works really great…
- Focused on short-range ordered local structures

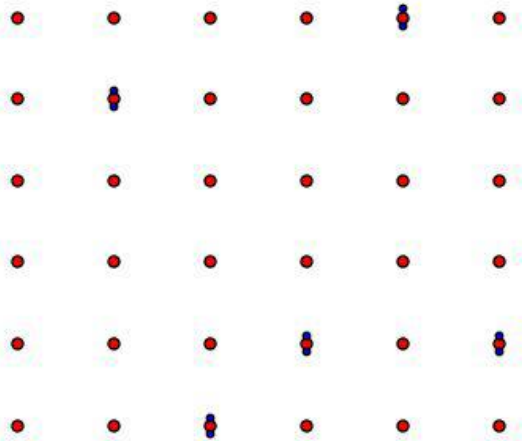
Day-to-day

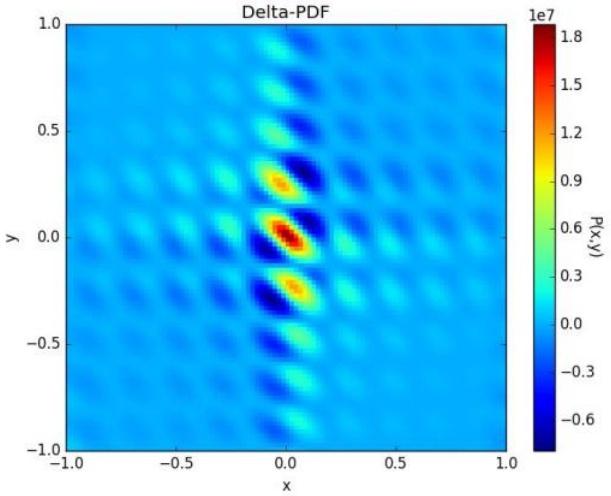
- Testing new method called 3D-∇PDF
- A lot of python
- Waiting for code to run
- Reading fun papers



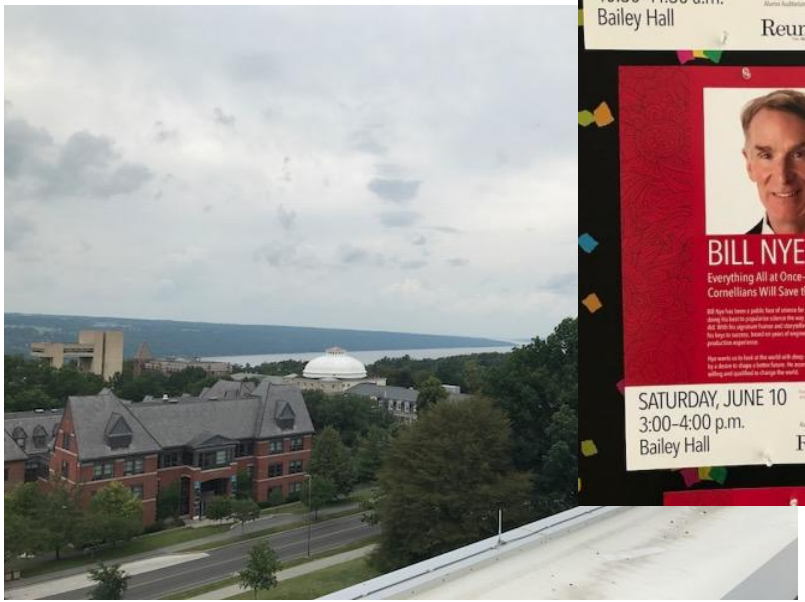


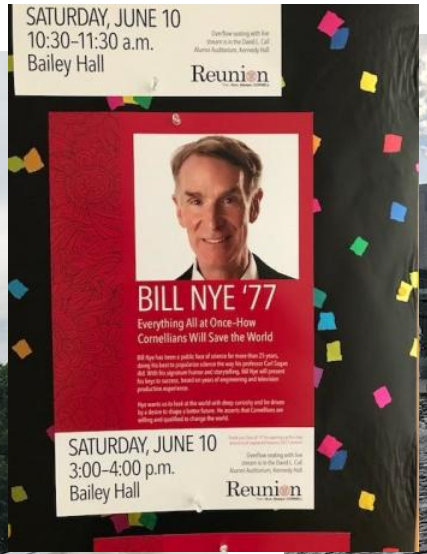
Final Results

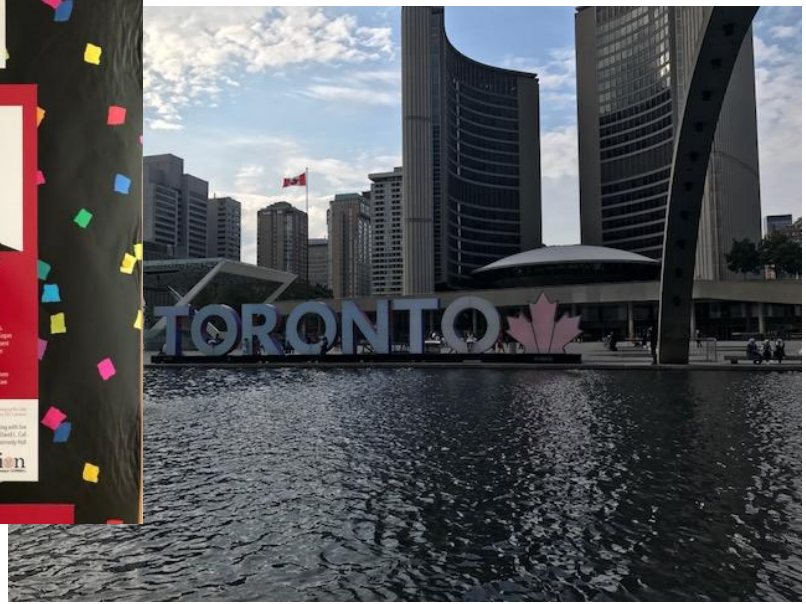




When Not Working





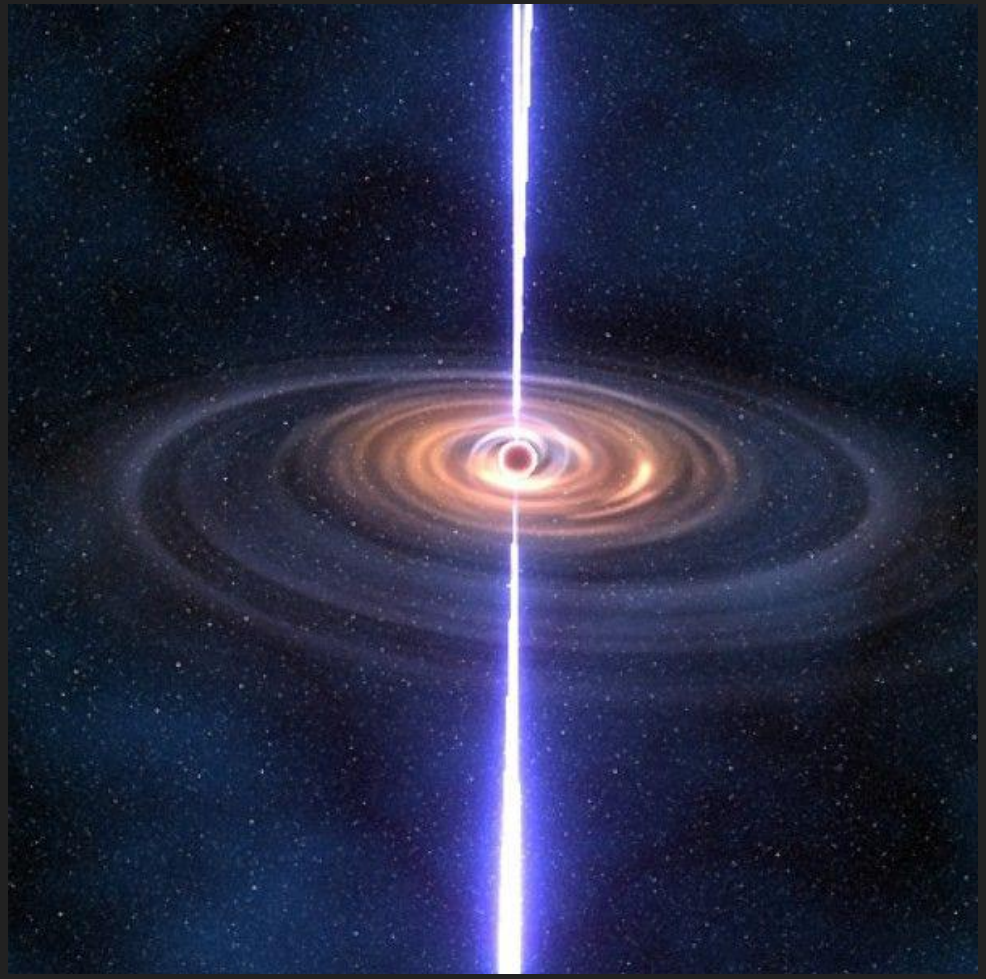


These people made it AWESOME

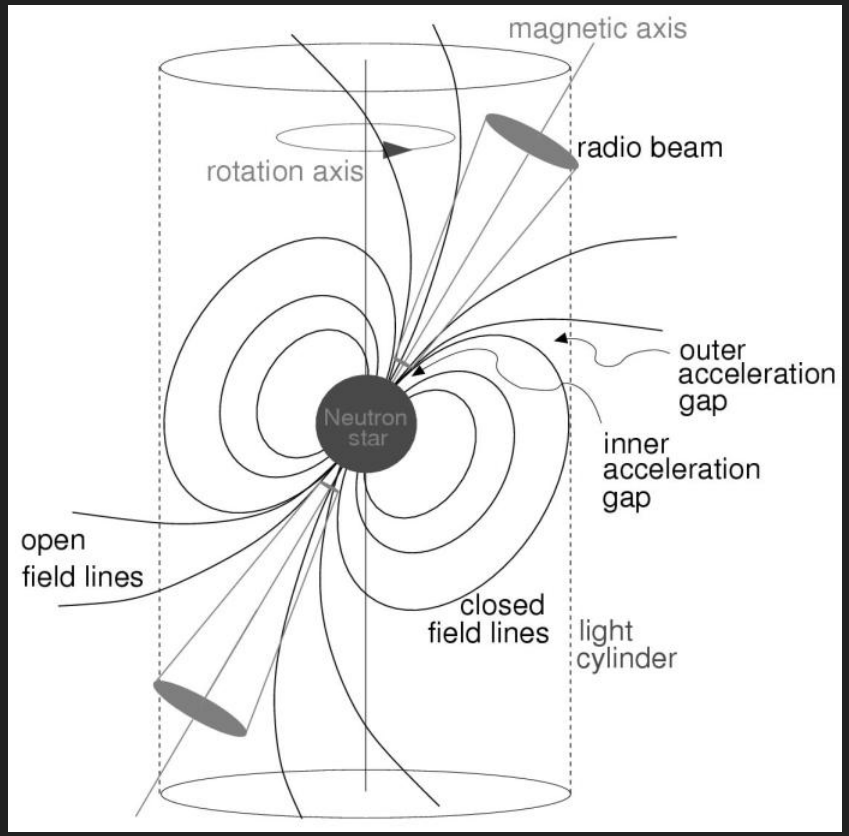
Inferring Binary Pulsar Population Statistics

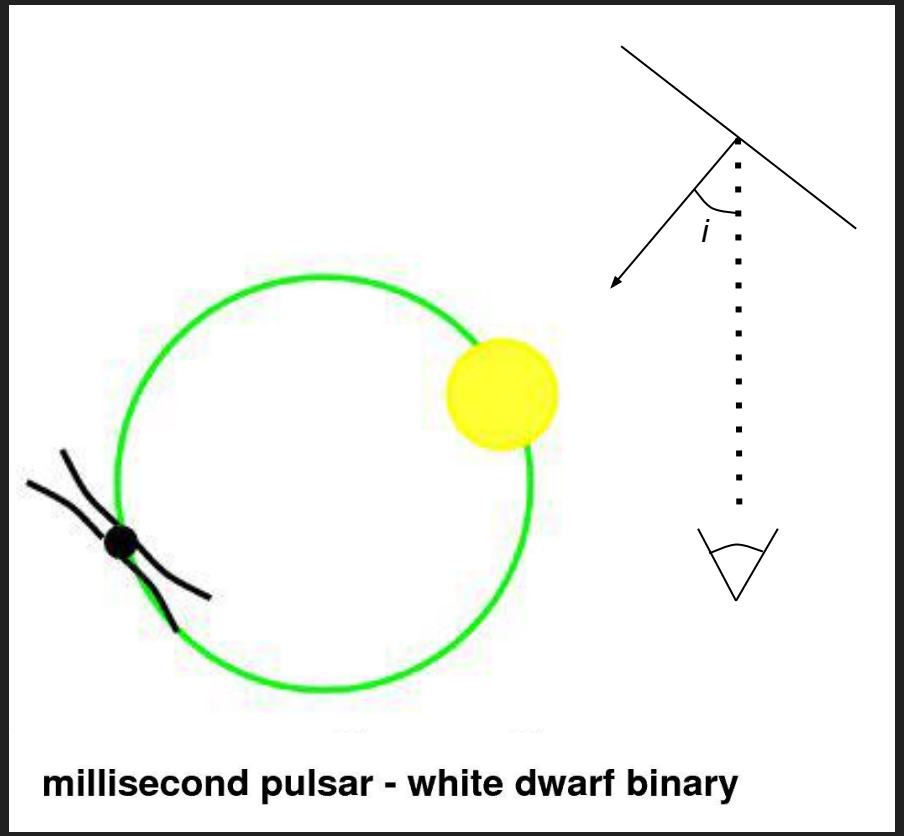
Steven Stetzler

Pulsars



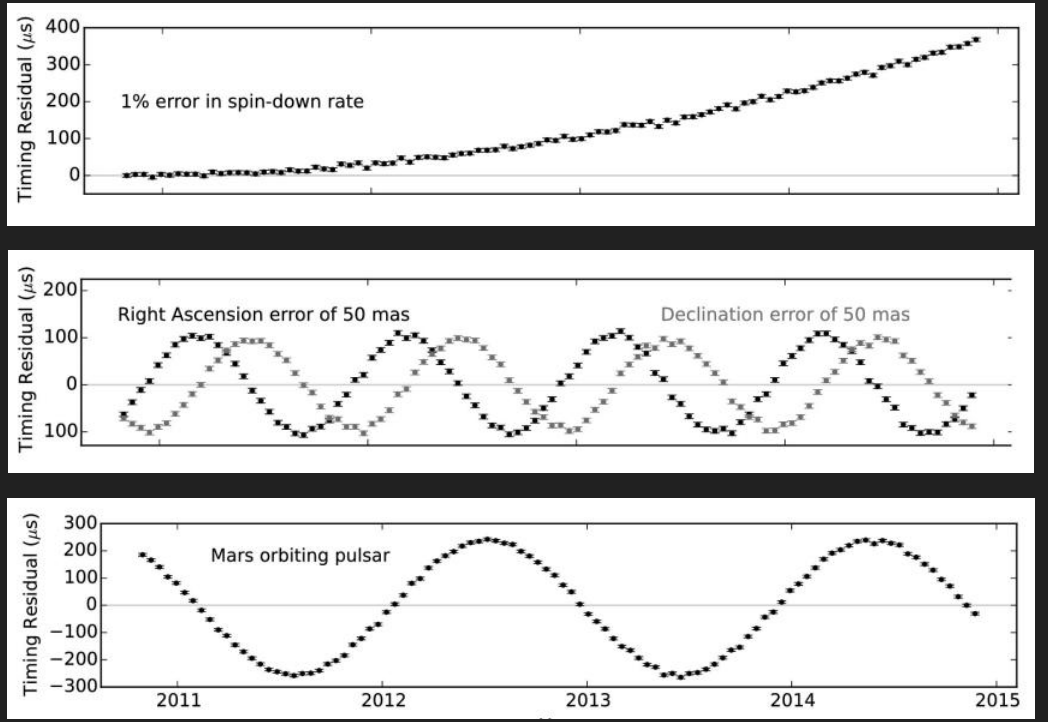
Pulsars


magnetic axis
rotation axis
radio beam
outer
acceleration
gap
Neutron
star
inner
acceleration
gap
open
field lines
closed
field lines
light
cylinder


i
millisecond pulsar - white dwarf binary

Pulsar Timing

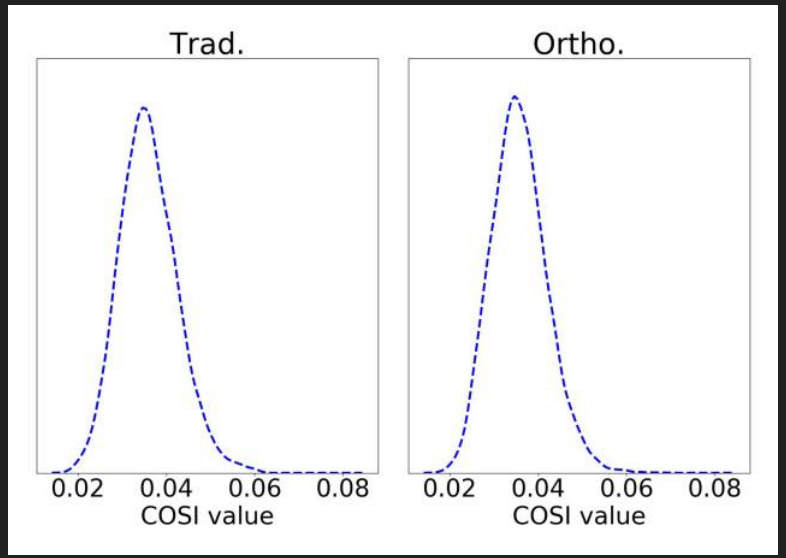
- Construct a model for when the next pulse will arrive
- All parameters model the physical reality of the pulsar or its binary orbit

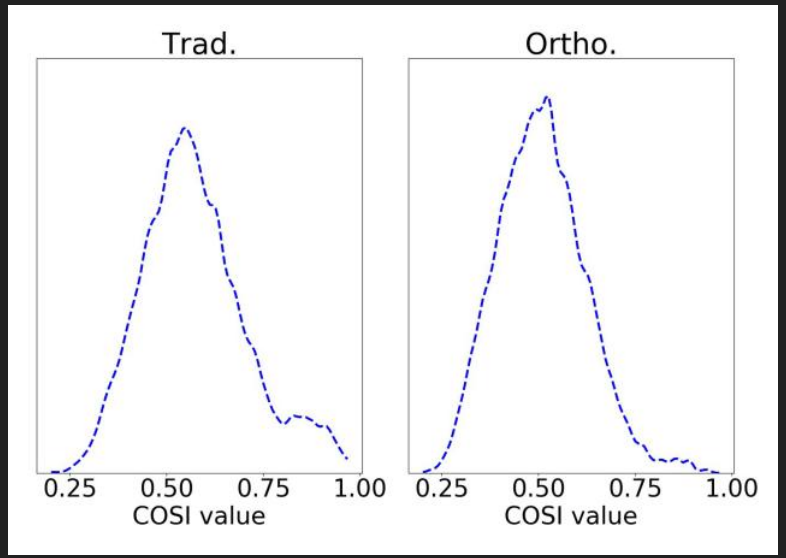


Are binary orbit inclinations uniformly distributed over the cosine of the inclination?

Bayesian Inference with Markov Chain Monte Carlo

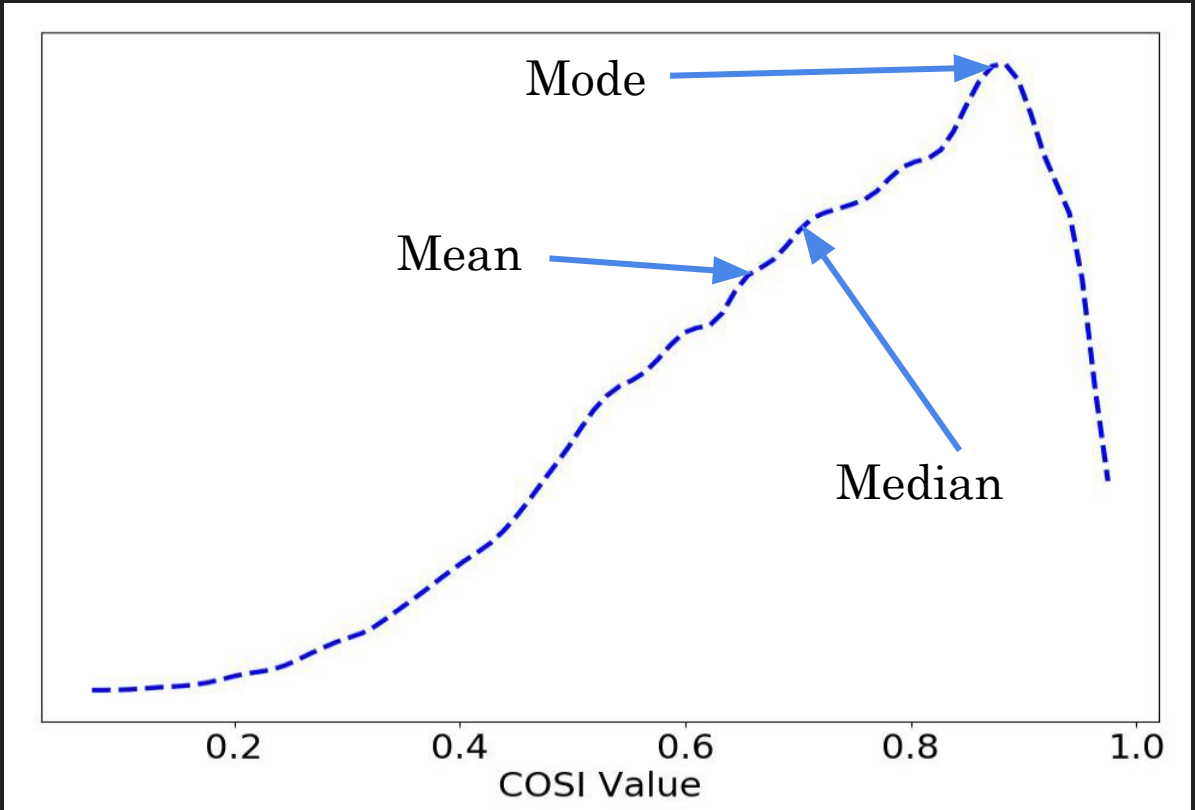
Allows us to efficiently explore parameters of our timing model and find full probability density functions (PDFs) for our parameters.





Statistical Tests with Representative Values

Take a representative value from each distribution

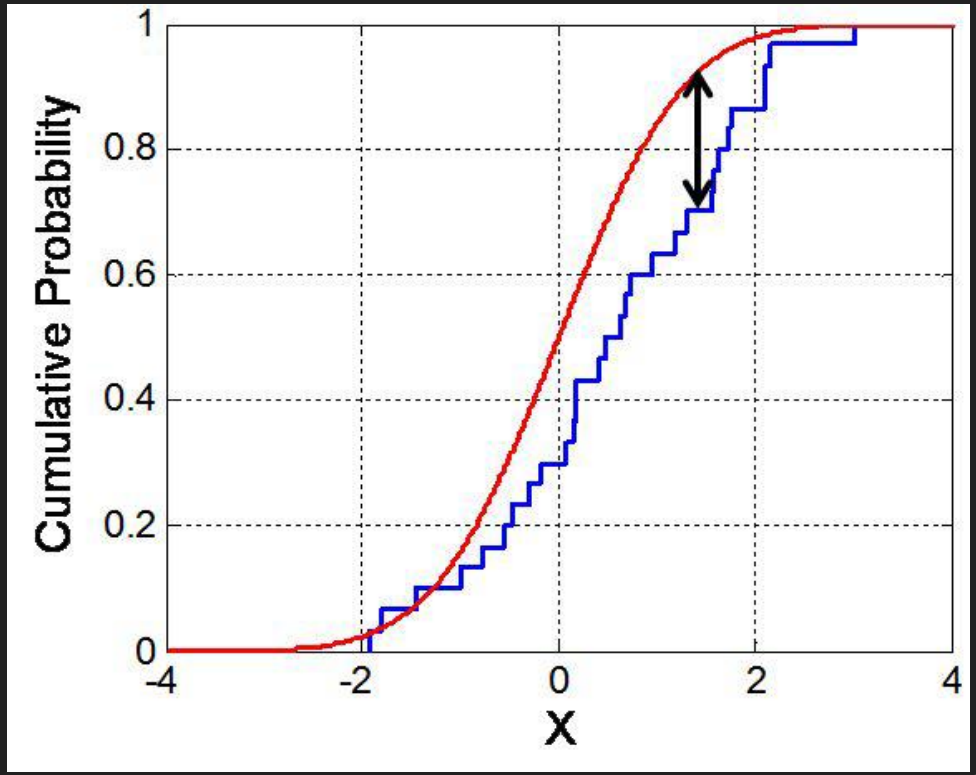


Statistical Tests with Representative Values

Anderson-Darling Test

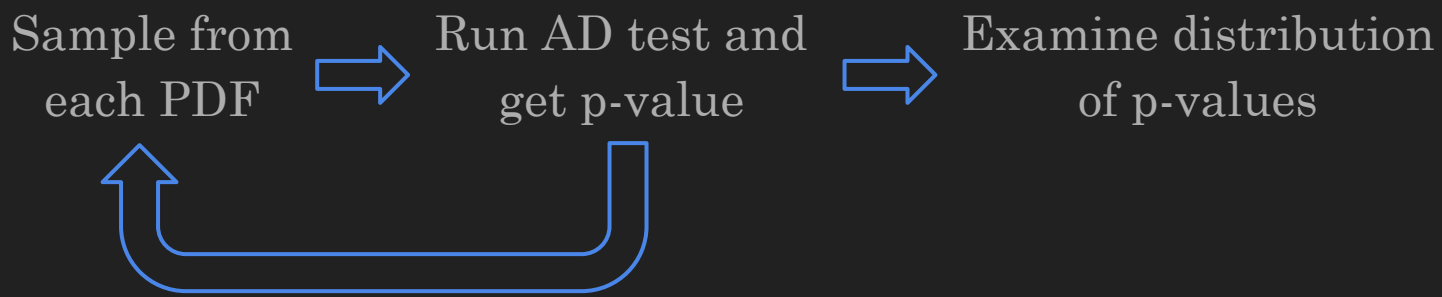
- Compares the cumulative distribution function (CDF) of your model to your data
- Answers: Does my data set come from this parent population?

Null: The data **is** from a uniform distribution



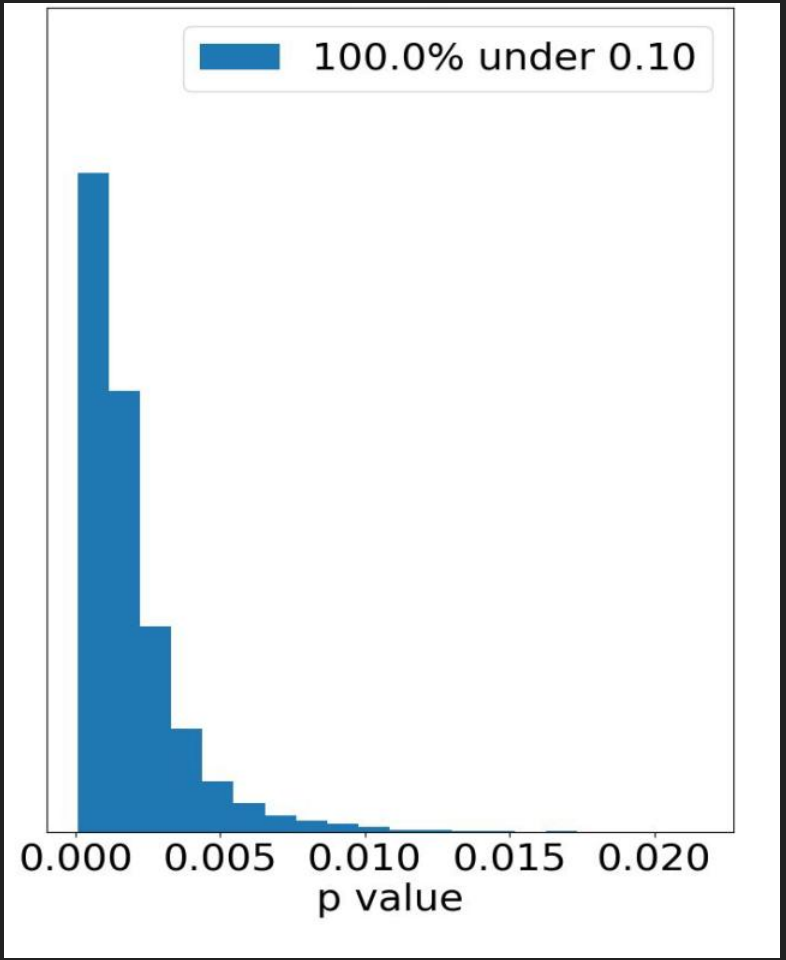
Statistical Tests with the Entire PDF

- Using a representative value reduces the entire PDF to a single value. What a waste!
- Proposed algorithm



Results

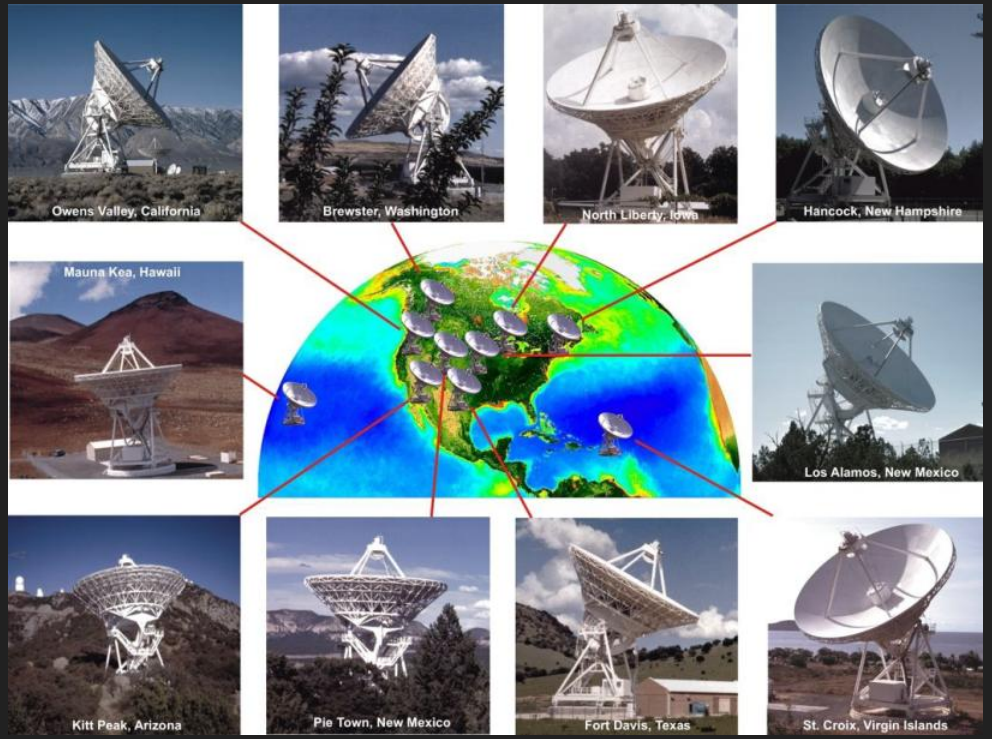
- Inconclusive … for now
- In talks with statisticians to verify results



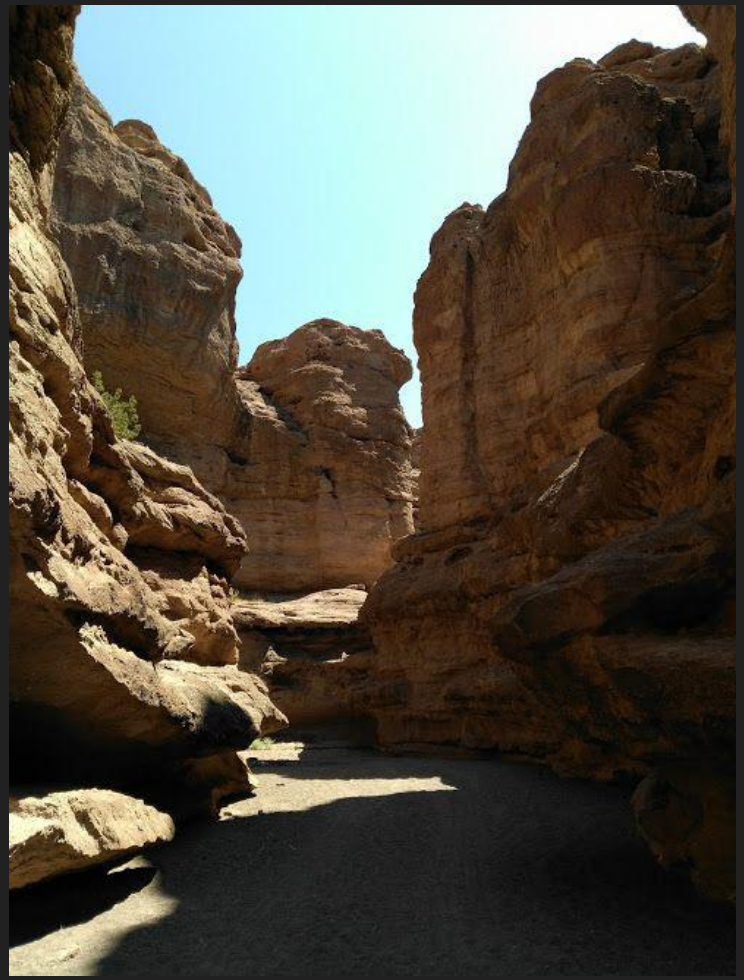
Day to Day

- Go into work late (but no one cares)
- Grab lots of coffee
- Meet with advisor
- Take an hour to socialize
- Sit down and program a lot
- Read half a paper (or a book) over lunch
- Get more coffee because the food made me tired
- Sit and contemplate future and existence
- Head home 8 - 9 hours later

SCIENCE!


Owens Valley, California
Brewster, Washington
North Liberty, Iowa
Hancock, New Hampshire
Mauna Kea, Hawaii
Los Alamos, New Mexico
Kitt Peak, Arizona
Pie Town, New Mexico
Fort Davis, Texas
St. Croix, Virgin Islands

FUN!

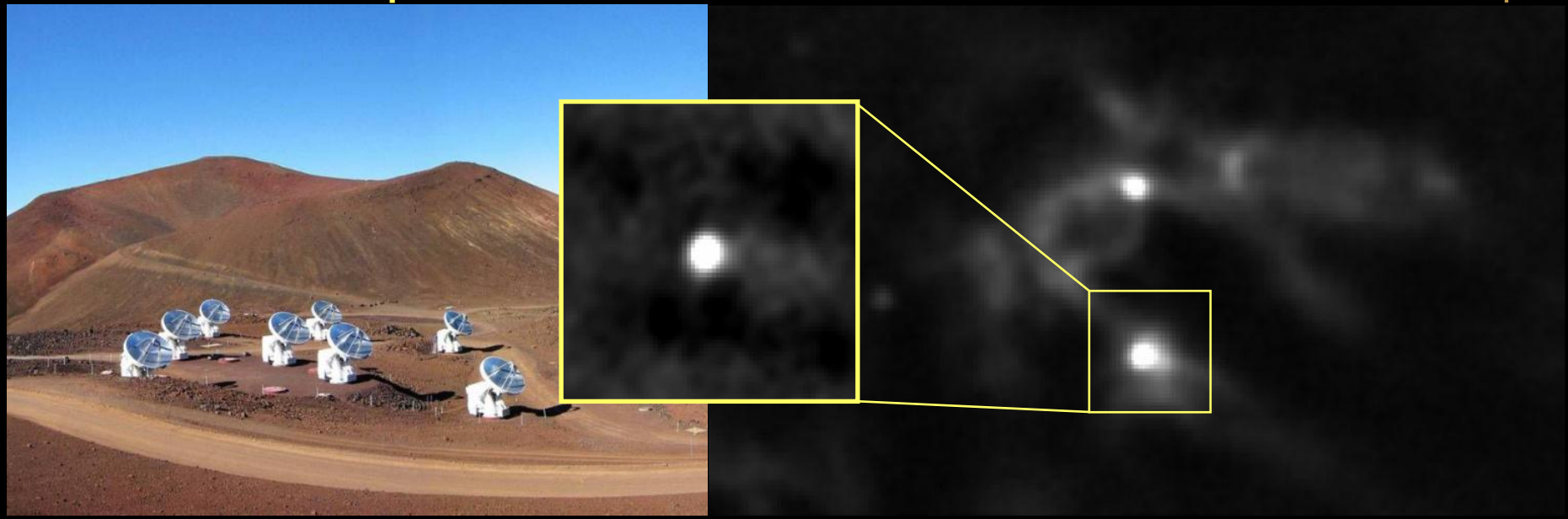


PEOPLE!


PETE V. DOMENICI SCIENCE OPERATIONS
NATIONAL RADIO ASTRONOMY OBSERVATORY
A facility of the National Science Foundation

Questions?

The Mass Evolution of Protostellar Disks and Envelopes in the Perseus Molecular Cloud



Bridget Andersen

4th Year Astrophysics and Computer Science Major

Harvard-Smithsonian Center for Astrophysics REU

The Current Model of Star Formation

We focus on Class 0 and Class I sources

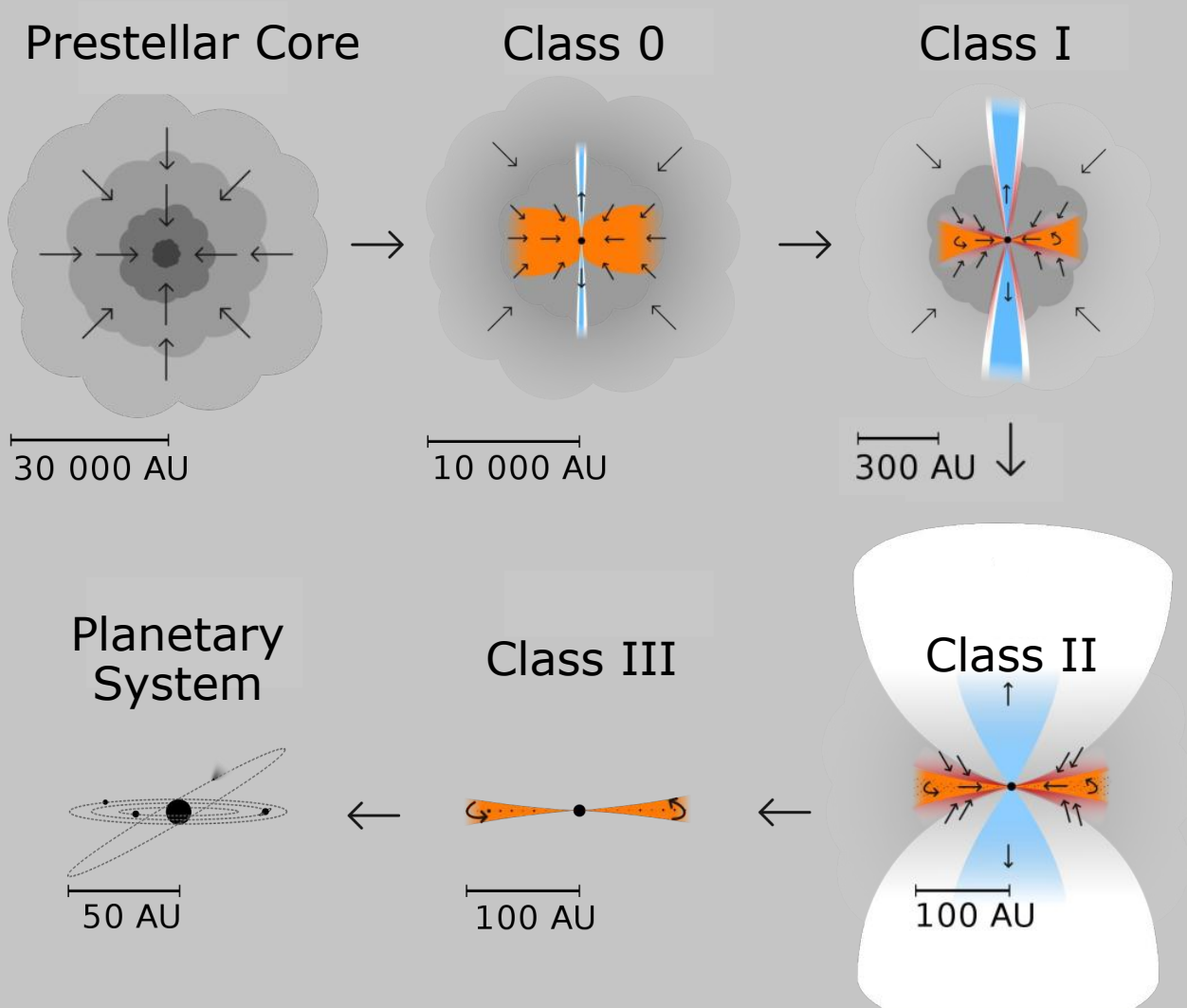


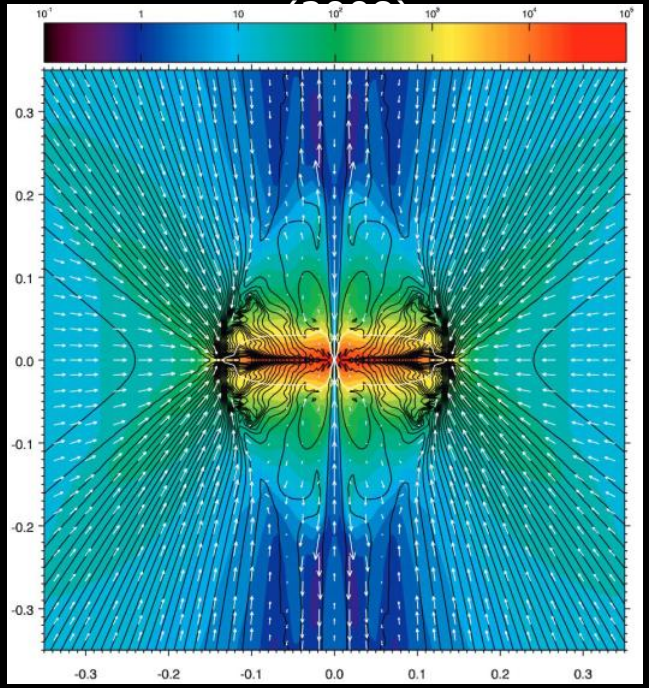
Diagram from M. Persson

Mass Evolution Timescales

Theoretical simulations allow many possibilities:

- Non-magnetic models: early massive disks
- Magnetic braking suppresses disk formation
- Some physical processes reduce magnetic braking

Mellon & Li



Disk and envelope emission are entangled in early embedded Class 0/I stages

Disk formation and envelope dissipation timescales are poorly constrained!

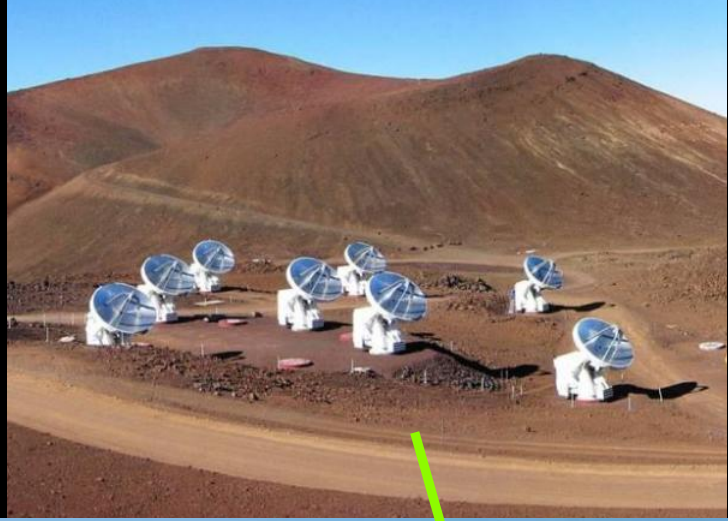
Jørgensen et al. (2009) Method

Uses interferometric data from the SMA to separate disk and envelope emission

The Submillimeter Array (SMA)

Eight 6 m dish array on Mauna Kea

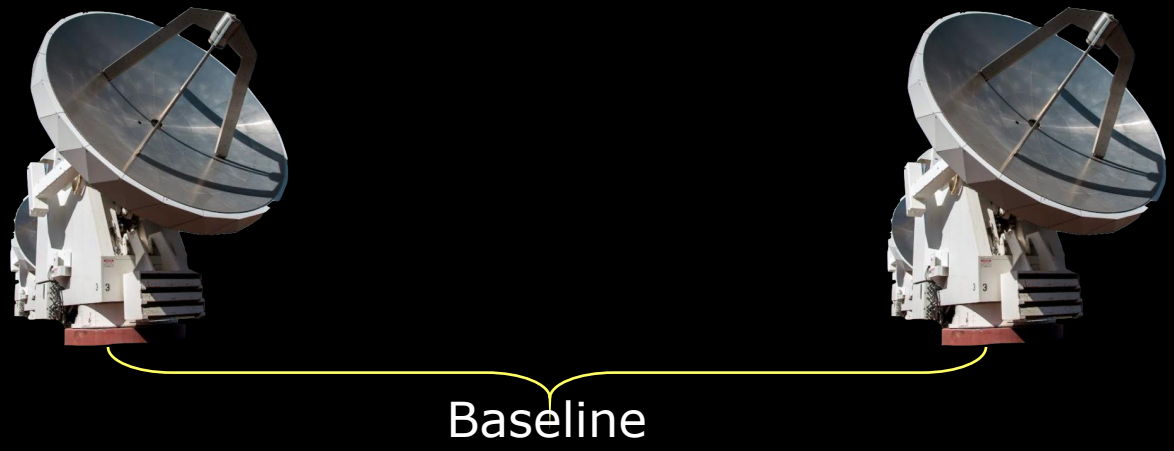
Wavelengths ~1 mm



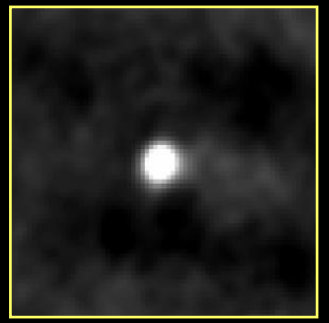
How Does the Jørgensen Method Work?

Fundamental component of an array: baseline

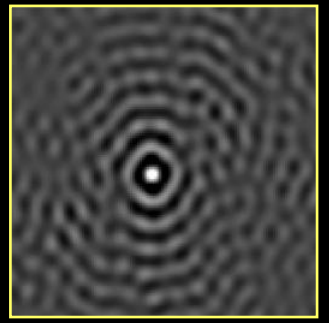
- Long baselines trace small-scale emission: disk
- Short baselines trace large-scale emission: envelope



All Baselines



Baselines >40kλ



Jørgensen et al. (2009):

- Uses SMA data from long (>40kλ) baselines to recover disk flux
- I applied the method to 59 sources in the Perseus molecular cloud

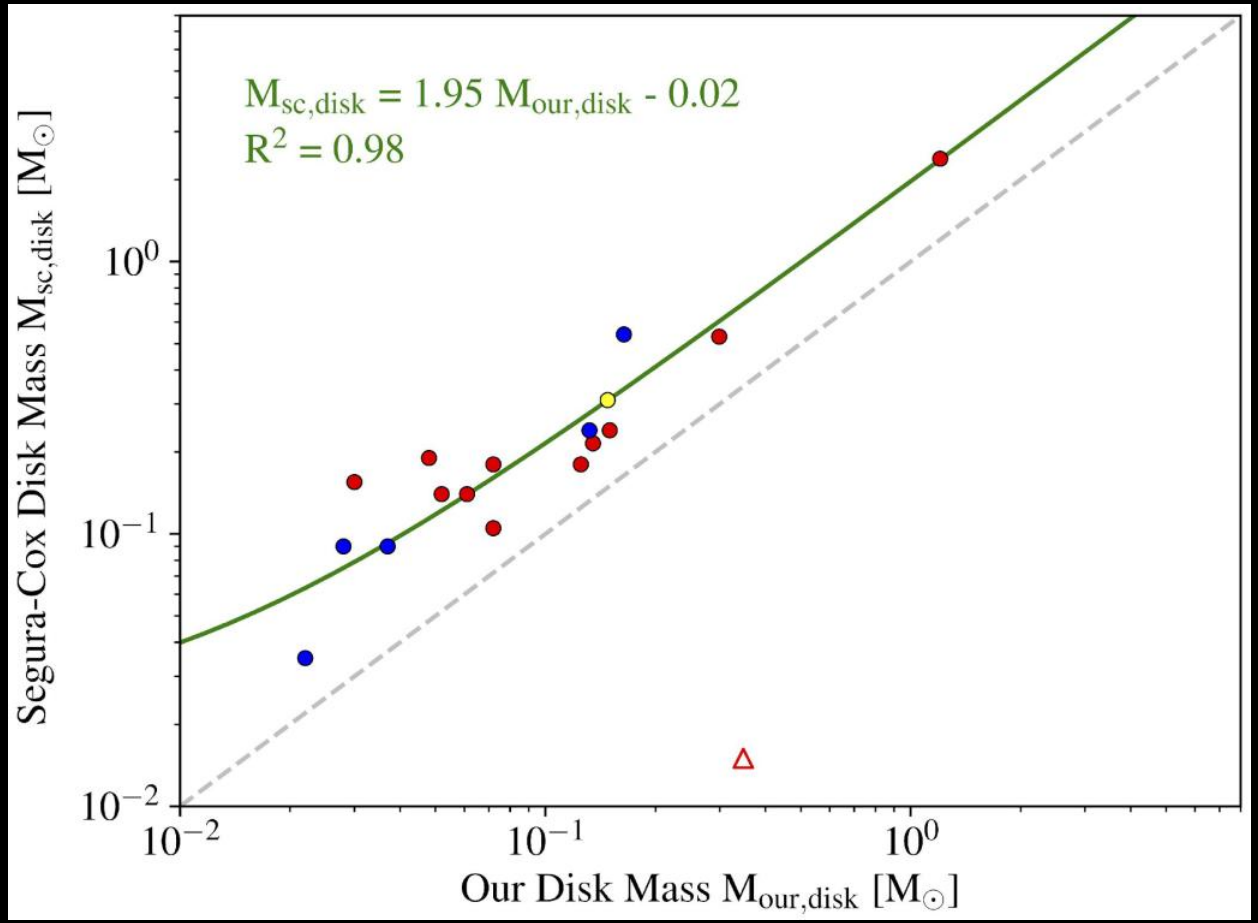
VLA Survey Disk Mass Comparison

Resolved survey of all sources in Perseus

Segura-Cox et al:
Found 18 disk candidates

Linear Fit: $R^2 = 0.98$

Supports validity of the Jørgensen method



Segura-Cox et al. (2016) and Segura-Cox et al. (in preparation)

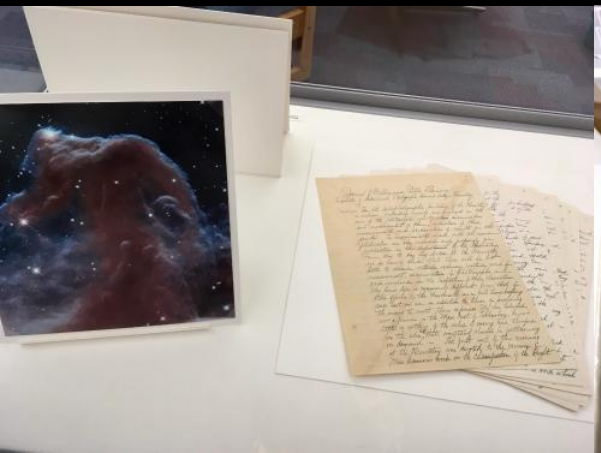
What else did I do this summer?

The CfA is one of the largest and most academically diverse astronomical institutions in the world!

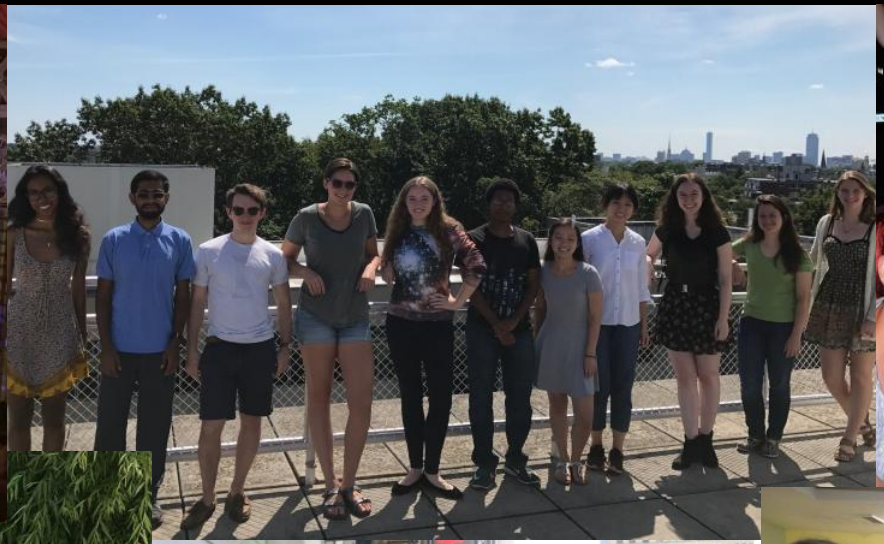
Attended TONS of colloquia and talks

Met a lot of cool people

REU program emphasized paper writing!

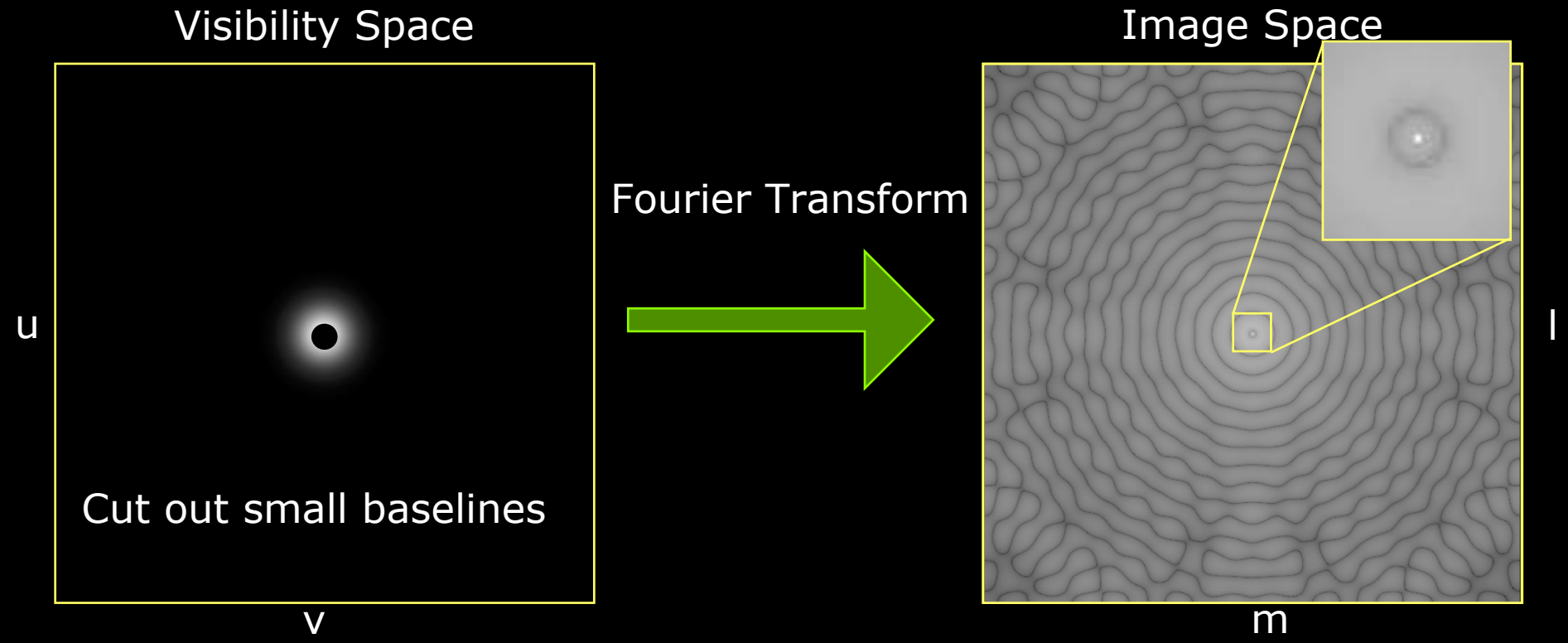


Explored Boston… Made lots of friends!



Questions?

Extra Slide: How Does the Jørgensen Method Work?



Jørgensen et al. (2009): simulations determined that JCMT/SCUBA single-dish flux contaminates at most 4% of interferometric flux at >40 kλ

Extra Slide Results: Disk Masses

Median disk masses:

0.05 $M_\odot$ for Class 0

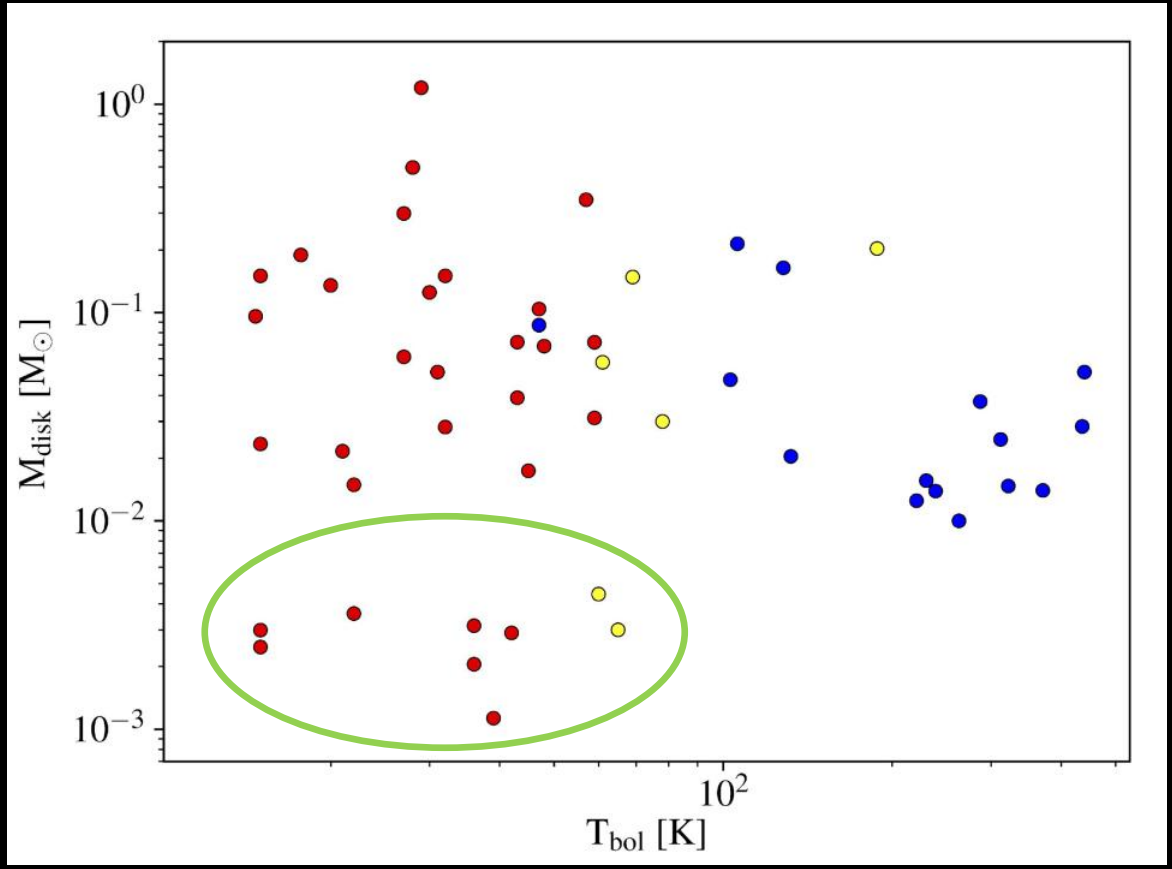
0.03 $M_\odot$ for Class I

Possible subgroup of low-mass $M < 0.005\ M_\odot$ and $T_{bol} < 100$ K sources

Magnetic braking?

No clear correlation in rest of data:

$R^2 = 0.20$



Red dots = Class 0 sources

Blue dots = Class I sources

Yellow dots = Class 0/I sources (ambiguity)