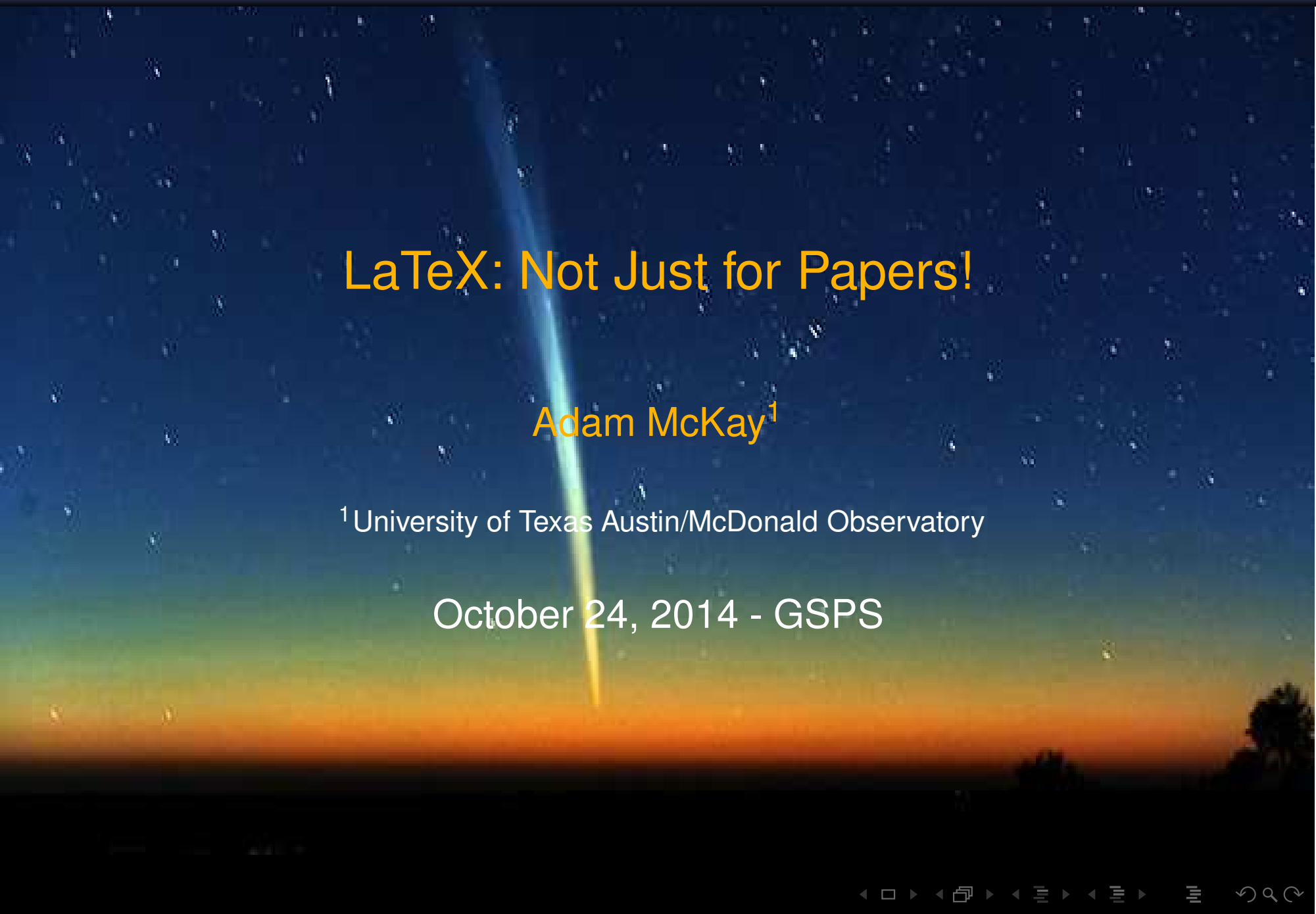

LaTeX: Not Just for Papers!

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October 24, 2014 - GSPS

Outline

What I do

- High resolution optical spectroscopy
- Lots of experience on ARCES at ARC 3.5-meter telescope at Apache Point Observatory, learning to use 2DCoude on the McDonald 107-inch
- Using forbidden oxygen line emission as a proxy for CO_2 in comets
- Understanding the photochemistry of the coma (comparison of optical and IR spectra)

A Common Misconception

- Q: Why are comets boring to study?

A Common Misconception

- Q: Why are comets boring to study?
- A: Because they are always in a coma!

A Common Misconception

- Q: Why are comets boring to study?
- A: Because they are always in a coma!
- Actually, the fact that they are in a coma makes them very interesting and challenging objects to study!

Case in Point: Comet ISON

- Up: Upon discovery hailed as “Comet of the Century”
- Down: Underperformed as it came closer to perihelion
- Up: Major outbursts gave renewed hope
- Up: Models predicted it would survive perihelion
- Down: SOHO images showed apparent disintegration event
- Up: Something emerged post-perihelion
- Down: Didn’t survive

CO_2/H_2O from Atomic Oxygen

- Photodissociation:
  H_2O + photon $\rightarrow$ H_2 + O(^{1}D)
  CO_2 + photon $\rightarrow$ CO + O(^{1}S)
- H_2O, CO_2, and CO release ^{1}S and ^{1}D OI with different efficiencies

$$R \equiv \frac{N(O(^1S))}{N(O(^1D))} = \frac{I_{5577}}{I_{6300} + I_{6364}} \quad (1)$$

- H_2O dominated case gives R=0.05-0.1, CO_2/CO dominated case gives R=0.6-0.8

CO_2/H_2O from Atomic Oxygen

CO_2/H_2O ratio given by (McKay et al. 2012):

$$\frac{N_{CO_2}}{N_{H_2O}} = \frac{R W^{1D}_{H_2O} - W^{1S}_{H_2O} - \frac{N_{CO}}{N_{H_2O}}(W^{1S}_{CO} - R W^{1D}_{CO})}{W^{1S}_{CO_2} - R W^{1D}_{CO_2}} \quad (2)$$

N=column density
R=oxygen line ratio
W=release rate (not well known!)

Observations

ARCES: $\frac{\lambda}{\Delta\lambda}$=31,000
HIRES: $\frac{\lambda}{\Delta\lambda}$=47,000
McDonald 2DCoude: $\frac{\lambda}{\Delta\lambda}$=60,000

UT Date	Instrument	Telescope	R (AU)	Δ (AU)	$\dot{\Delta}$ (km/s)
Oct 3	ARCES	APO	1.61	2.09	-50.9
Oct 18-21	2DCoude	McDonald	1.29	1.61	-51.9
Oct 25	HIRESb	Keck I	1.16	1.43	-50.9
Oct 28	HIRESb	Keck I	1.09	1.34	-50.0
Nov 6	ARCES	APO	0.87	1.10	-43.5
Nov 15	ARCES	APO	0.62	0.91	-25.7
Nov 20	ARCES	APO	0.46	0.86	-6.2

What are Comets?

- Consists of a small body of ice and dust called the nucleus when far from the Sun
- Surface ices begin to sublimate as the comet moves towards the Sun

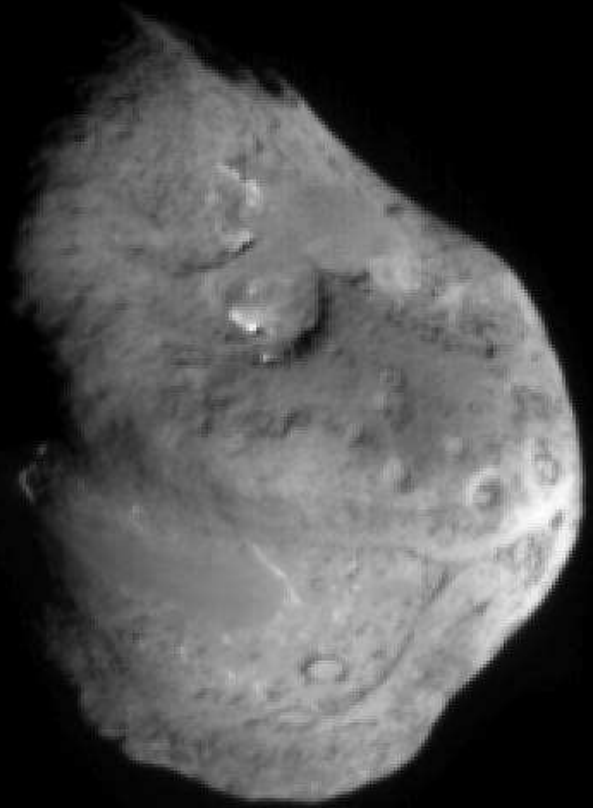


Image Credit: NASA JPL

Cat Pictures!

More Cat Pictures!

This cat is hungry!

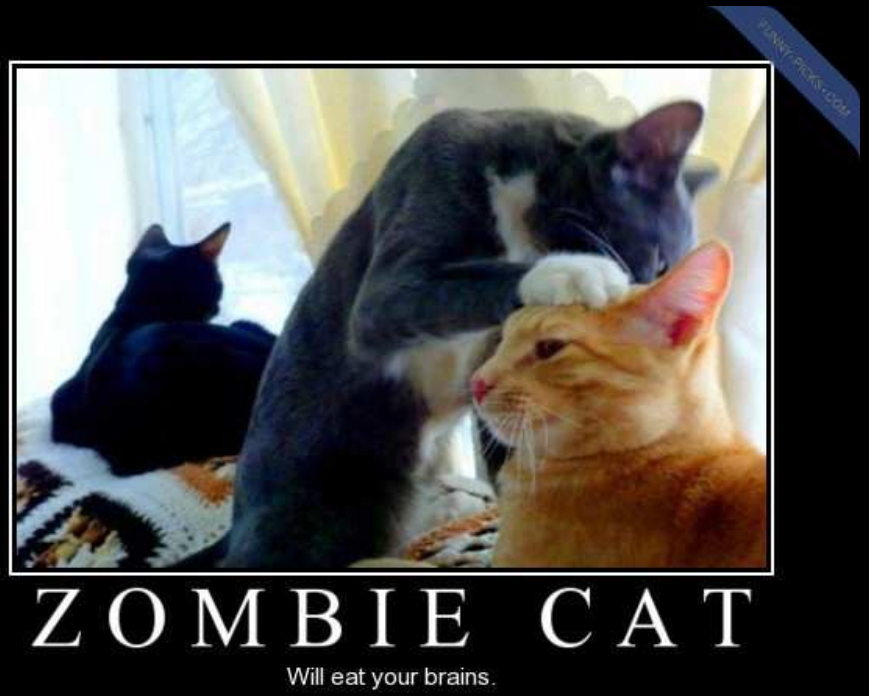
This cat is hungry!

This cat is hungry!

This cat is hungry!

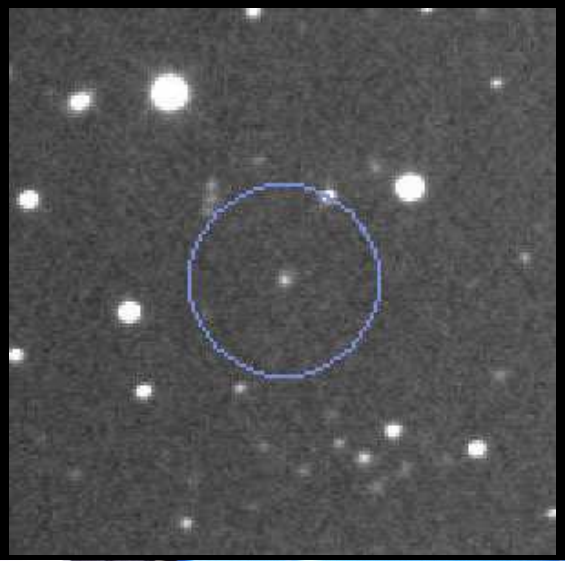
More Cat Pictures!

No brains are safe.



Case in Point: Comet ISON

- Discovered in September 2012 outside of Jupiter's orbit
- Found to be on a sungrazing orbit, created lots of hype as "Comet of the Century"



Of Comets and Cats

"Comets are like cats: they have tails, and they do precisely what they want." - David Levy

Case in Point: Comet ISON

- Light curve flattened, not getting brighter even though it was moving toward the Sun
- Lost behind the Sun in Summer 2013, no observations available until August

Case in Point: Comet ISON

Comets are like cats!

See you at Crown!