



Transient Response Astronomy

How & Why

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(present & past Chairs of the IVOA VOEvent WG)

Many meetings since 2005



- ✦ VOEvent workshops
- ✦ HTN workshops
- ✦ Transient Universe 2006 meeting
- ✦ Hotwired meetings (<http://hotwireduniverse.org>)
- ✦ IVOA sessions (VOEvent & Semantics WGs)
- ✦ ADASS BoFs
- ✦ NVO Summer Schools
- ✦ SPIE 2006
- ✦ VOEventNet meeting
- ✦ Robots at the Austin AAS

More meetings coming...

- ✦ IVOA InterOp – 9-13 Nov 2009
- ✦ dotAstronomy – 30 Nov - 4 Dec 2009
- ✦ *The Eventful Universe* (NOAO 50th) – 17-20 Mar 2010
- ✦ IVOA InterOp – 17-21 May 2010
- ✦ VAO @ AAS – 23-27 May 2010
- ✦ SPIE 2010, *Observatory Operations III* – 27 Jun - 2 Jul 2010
- ✦ ADASS XX BoF – 7-11 Nov 2010
- ✦ 2011 – Hotwired III
- ✦ 2012 – Joint Discussion @ IAU General Assembly?
 - ✦ Comm. 5 (WG-VO) & Comm. 6 (Astronomical Telegrams)

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Transient Response Astronomy

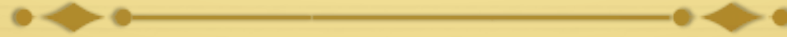
How & Why

Sherlock Holmes



The patron saint of How & Why,
suggesting a different title...

...or



The Giant Rat of Sumatra

*“...a story for which the world
is not yet prepared.”*

- “The Adventure of the Sussex Vampire”
by Sir Arthur Conan Doyle

Why transient response?

- ✦ Things go bump in the night
 - ✦ the sky is big
 - ✦ transients are rare
 - ✦ events occur randomly in space & time
 - ✦ ...and have obscure physical signatures
 - ✦ *vs.* contention for observing resources
- ✦ Even giant rats can be hard to find



“A halfassed comeback containing only one good joke.” - *Rolling Stone*

Why? The Rat has friends



- ✦ Large Synoptic Survey
- ✦ Pan-STARRS
- ✦ Dark Energy Survey
- ✦ ...

The Rat is rare & valuable

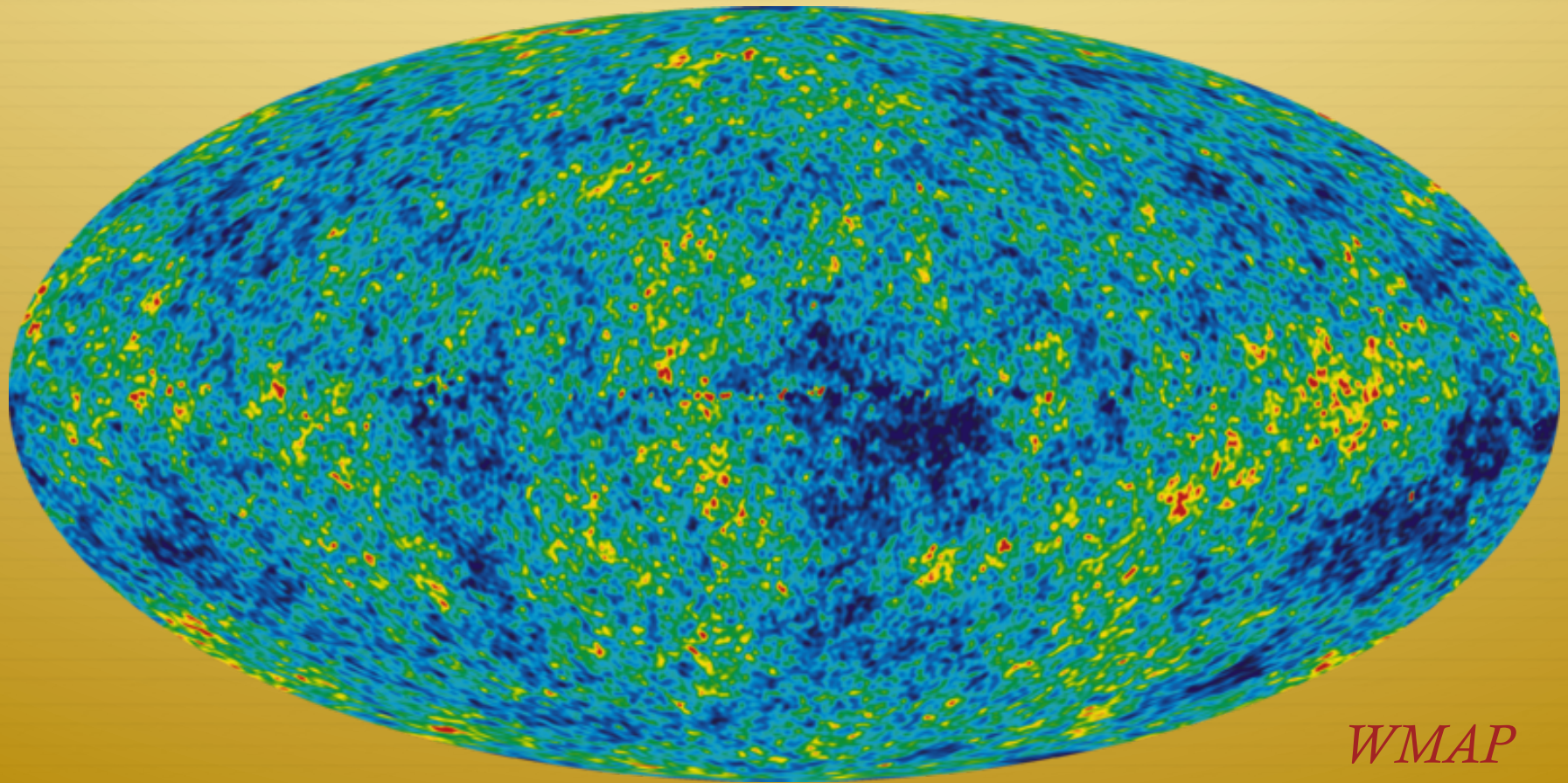


- ✦ Gamma-Ray Bursts
- ✦ Neutrinos
- ✦ Gravitational waves
- ✦ Solar system debris
- ✦

The Rat will always remain a target-of-opportunity, requiring:

- ✦ Rapid response
- ✦ Ubiquitous delivery
- ✦ Diverse subscribers
- ✦ Flexible follow-up
- ✦ Reliable semantic classification
- ✦ Autonomous workflows
- ✦ We must build a better rat-trap

But the Rat lives within a
background limited universe



✦ Further in space,
Deeper in time

✦ Transients are
milestones in the
master timeline of
cosmic history

✦ Distant transients
probe the moment
of creation

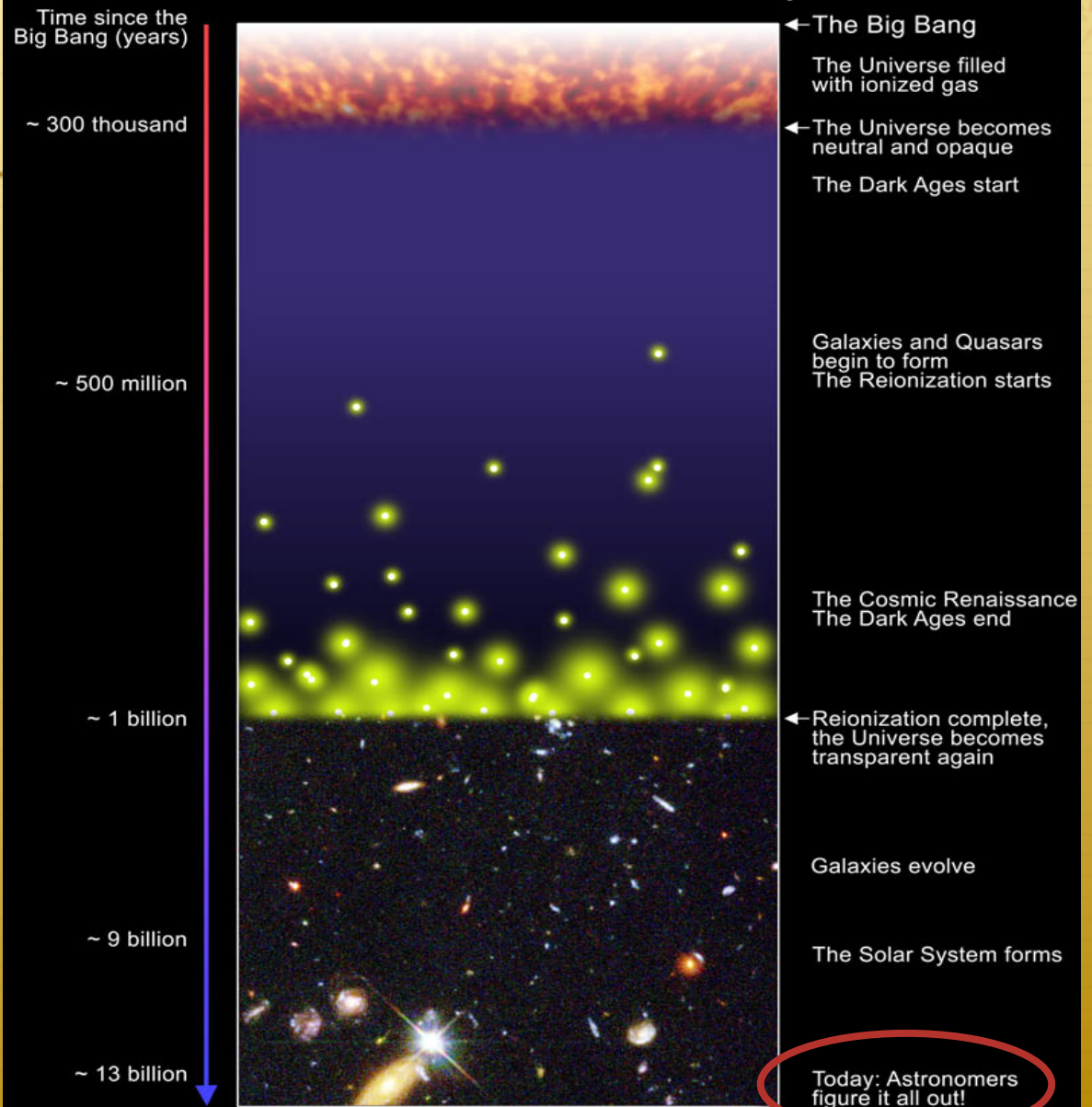
✦ Local transients
are close enough
to touch

meteors, comets, ...

ADASS XIX, Sapporo, Japan

What is the Reionization Era?

A Schematic Outline of the Cosmic History



S.G. Djorgovski et al. & Digital Media Center, Caltech

How to respond to transients?



✦ To quote from Sherlock Holmes:

“Results without causes are much more impressive.”

How?



- ✦ The **VOEvent** standard of the IVOA is one ingredient for constructing flexible, efficient, autonomous architectures for carrying out experimental investigations when time is of the essence.

How?

- ✦ “**VOEvent** defines the content & meaning of a standard information packet for representing, transmitting, publishing & archiving the **discovery** of a transient celestial event, with the implication that **timely follow-up** is being requested.”

VOEvent

- ✦ Who
- ✦ What
- ✦ Where
- ✦ When
- ✦ How
- ✦ Why

VOEvent



- ✦ Who – author's provenance
- ✦ What
- ✦ Where
- ✦ When
- ✦ How
- ✦ Why

VOEvent



- ✦ Who – author's provenance
- ✦ What – empirical measurements
- ✦ Where
- ✦ When
- ✦ How
- ✦ Why

VOEvent

- ✦ Who – author's provenance
- ✦ What – empirical measurements
- ✦ Where – targeting in space
- ✦ When – constraints in time
- ✦ How
- ✦ Why

VOEvent

- ✦ Who – author's provenance
- ✦ What – empirical measurements
- ✦ WhereWhen – targeting in spacetime
- ✦ How
- ✦ Why

VOEvent

- ✦ Who – author's provenance
- ✦ What – empirical measurements
- ✦ WhereWhen – targeting in spacetime
- ✦ How – instrumental signature
- ✦ Why

VOEvent

- ✦ Who – author's provenance
- ✦ What – empirical measurements
- ✦ WhereWhen – targeting in spacetime
- ✦ How – instrumental signature
- ✦ Why – scientific characterization

VOEvent



✦ IVOA recommendation:

✦ <http://www.ivoa.net/Documents/latest/VOEvent.html>

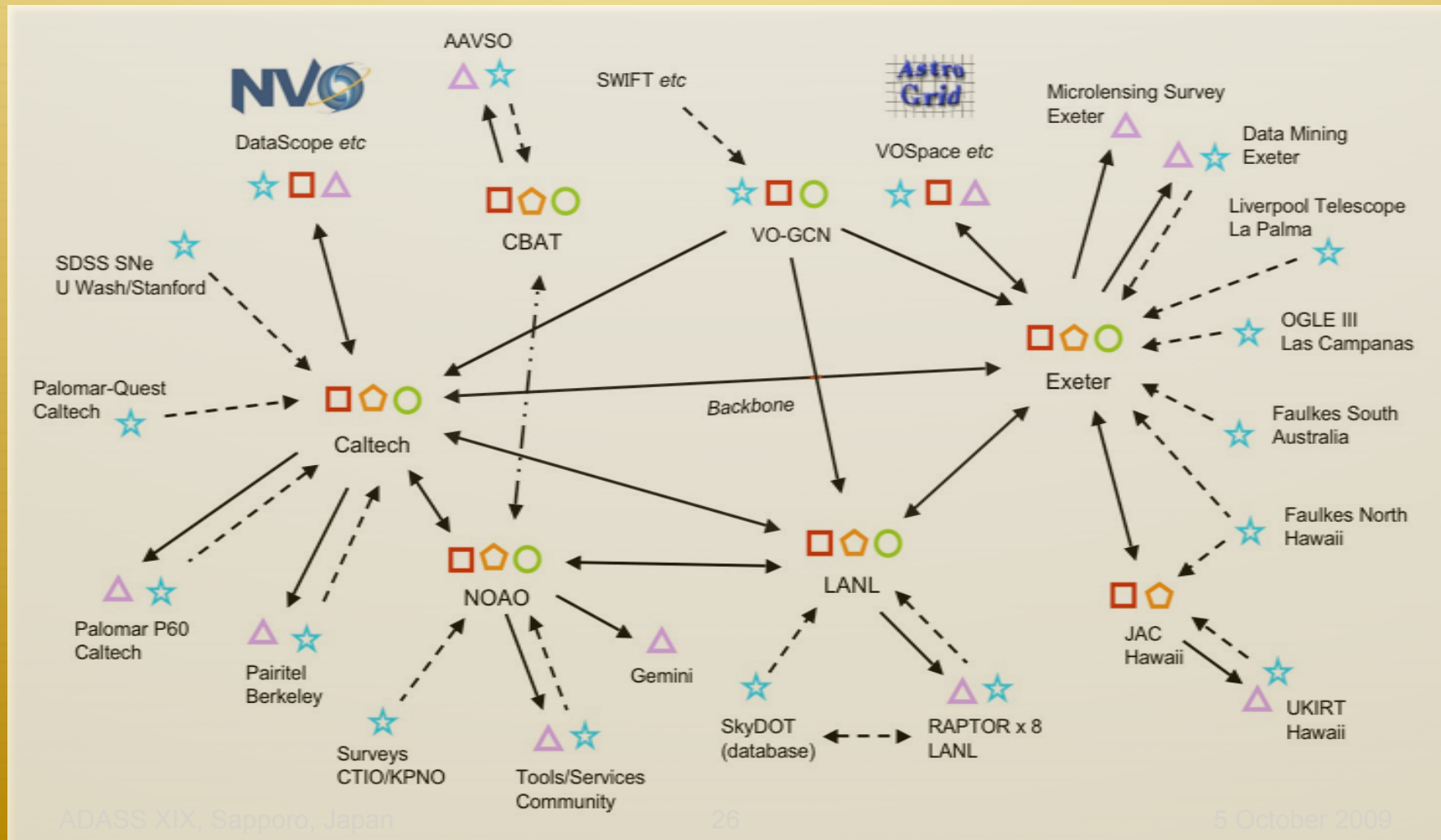
✦ XML schema:

✦ <http://www.ivoa.net/xml/VOEvent/VOEvent-v1.1.xsd>

✦ Working group:

✦ <http://voevent.org>

VOEventNet



VOEventNet



- ✦ Publish / Subscribe paradigm
- ✦ Backbone sites – full packet feeds
- ✦ Network of brokers
 - ✦ forwarding
 - ✦ filtering
 - ✦ bridging

VOEvent is transport-neutral



✦ Backbone:

- ✦ TCP “vanilla”

- ✦ Jabber

- ✦ XML-RPC

✦ Clients:

- ✦ SMTP, SMS, RSS, ...

VOEvent is IVOA-aware

- ✦ SEAP – Simple Event Access Protocol
- ✦ STC
- ✦ Vocabularies & semantics
- ✦ VOTable
- ✦ SAMP-enabled
- ✦ ...

VOEvent is **growing**


- ✦ V2.0 (time series, orbital elements, ...)
- ✦ VOEventStreams in registry
- ✦ SEAP
- ✦ Infrastructure (& transport)
- ✦ Client applications (author & subscribe)
- ✦ Community (eg., LSST data challenge)

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Sherlock Holmes on Transient Response Astronomy


- ✦ “When you have excluded the impossible, whatever remains, however improbable, must be the truth.”
- ✦ In the time domain, astronomers study unprecedented phenomena subject to dramatically differing interpretations.



✦ “Chance has put in our way a most singular and whimsical problem, and its solution is its own reward.”

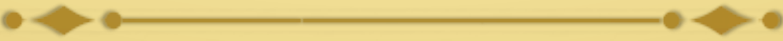
✦ Serendipity is the engine of discovery.


✦ VOEvent is a luck management system.





✦ “The world is full of obvious things which nobody by any chance ever observes.”


✦ Taking advantage of rare opportunities requires careful planning and the deployment of resources in advance.


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- ✦ “It is a capital mistake to theorize before you have all the evidence. It biases the judgment.”
 - ✦ Science depends on synthesizing diverse observations to discover underlying rules, that is, on building empirical workflows.

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- ✦ “I am glad of all details, whether they seem to you to be relevant or not.”
 - ✦ Filtering of data should be postponed to as late in the workflow as possible.
 - ✦ Different investigators need different things from the event stream.

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- ✦ “The reasoner can produce an effect which seems remarkable to his neighbor, because the latter has missed the one little point which is the basis of the deduction.”
 - ✦ Information without efficient access and effective query tools is useless.

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- ✦ “I have no desire to make mysteries, but it is impossible at the moment of action to enter into long & complex explanations.”
 - ✦ Autonomous systems are needed to allow removing humans from the loop.

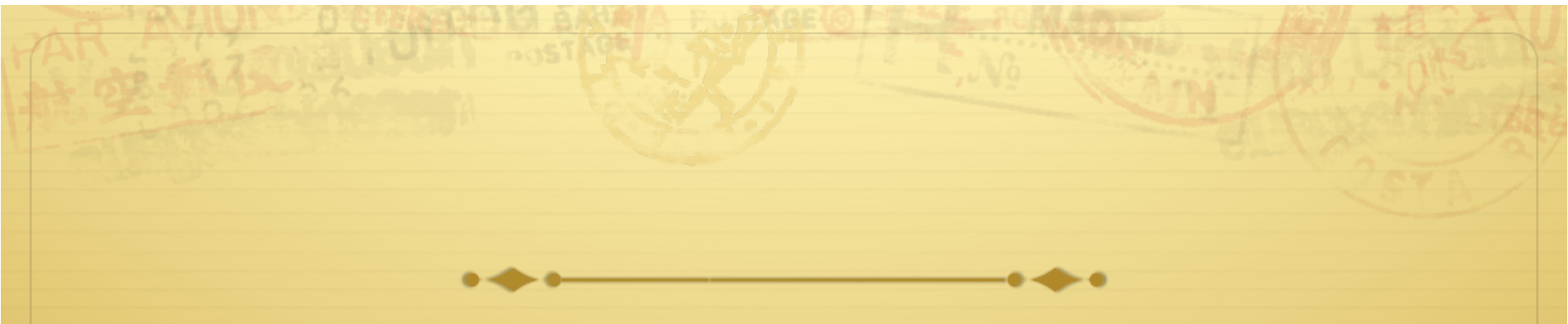
- 
- ✦ “What one man can invent, another can discover.”
 - ✦ Astronomy requires a standard transient alert protocol
 - ✦ ...only a *single* transient alert protocol.



✦ “I wonder how a battery feels when it pours electricity into a non-conductor.”


✦ Astronomy requires a common transient alert network

✦ ...only a *single* transient alert network.




✦ “My life is spent in one long effort to escape from the commonplace of existence.”


✦ Time domain projects (synoptic as well as transient-response) require commitment to a lengthy and diligent search process.



✦ “Nothing clears up a case so much as stating it to another person.”

✦ A publish-subscribe paradigm is needed to connect surveys that discover celestial transients with the astronomical assets used to study these events.

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- ✦ “Only one important thing has happened in the last three days, and that is that nothing has happened.”
 - ✦ Steady state behavior is also significant in classifying, characterizing and understanding phenomena.

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- ✦ “It is the second most interesting object that I have seen in the North.”
 - ✦ Celestial transient alerts must convey human-oriented context and semantics.
 - ✦ ...even as humans recede from direct control of observatory systems.

Two more quotes from Holmes



- ✦ “Mrs. Hudson has been knocked up!”
- ✦ “If you approach me, Watson, I shall order you out of the house.”

The game is afoot!



Coming soon, our book:

<http://hotwireduniverse.org>

Questions?