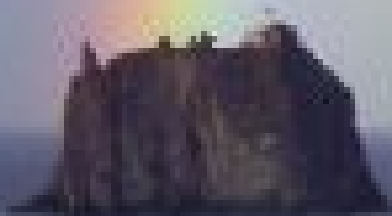
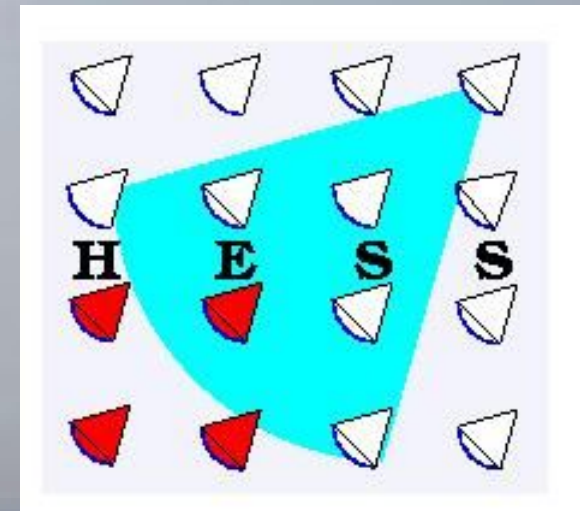


How is HESS approaching multiwavelength observations?

An Introduction

(with apologies to nearly everybody)

Stefan J. Wagner
Landessternwarte
Heidelberg





Multiwavelength Studies
and
Multimessenger Strategies

Multimessenger Strategies

Using the H.E.S.S. experiment as an example, multimessenger strategies are reviewed.

For H.E.S.S., this is (so far) almost exclusively limited to photons of different energies (multiwavelength studies) and is being dealt within a generic physics working group



Why do we bother about MWL ?

We want to know what we are looking at

a) Spatially (Identification)

b) Physically (Processes)

How do we bother about MWL ?

Specifically:

**Once a source of TeV gamma emission is detected
(where is it?),
we try to determine “what is it?”**

- a) searching catalogues for identified sources**
- b) searching archives for uncatalogued sources**
- c) obtaining and analysing new observations**
- d) organising simultaneous observations**

Multiwavelength working group

25/100 members of the HESS collaboration

<http://www.lsw.uni-heidelberg.de/projects/hess/HESS>

Linked to all other working groups

Examples: Surveys, SPP, AGN, Binaries

Searching archives for ID of new sources

Obtain MWL information: a) Archives

b) New data

- Cooperation

- Application

- Analysis

Organize simultaneous observations

Identification

?

What is the source?

What are the processes?

A problem of many layers, which is difficult to deal with in an abstract way.

Assuming Stationarity

Stationary signals simplify the quest.

This is not always the case:

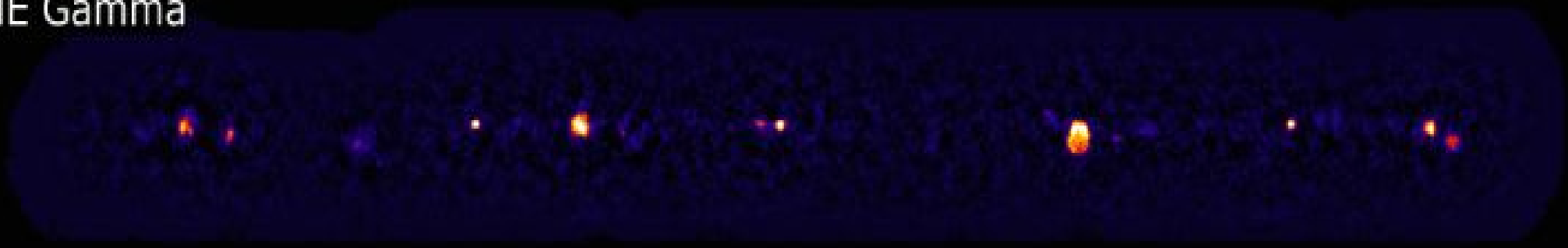
One of the most difficult problems in the recent past: Understanding GRBs
(Gamma Ray Bursts)

Multimessenger Context:
Neutrinos from SN 1987A

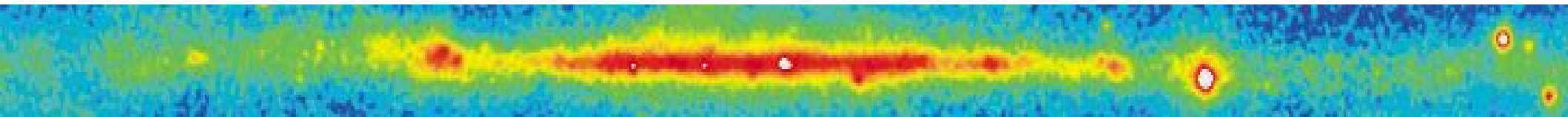
A new source is detected

Astrometry: Position, (size, morphology)

VHE Gamma



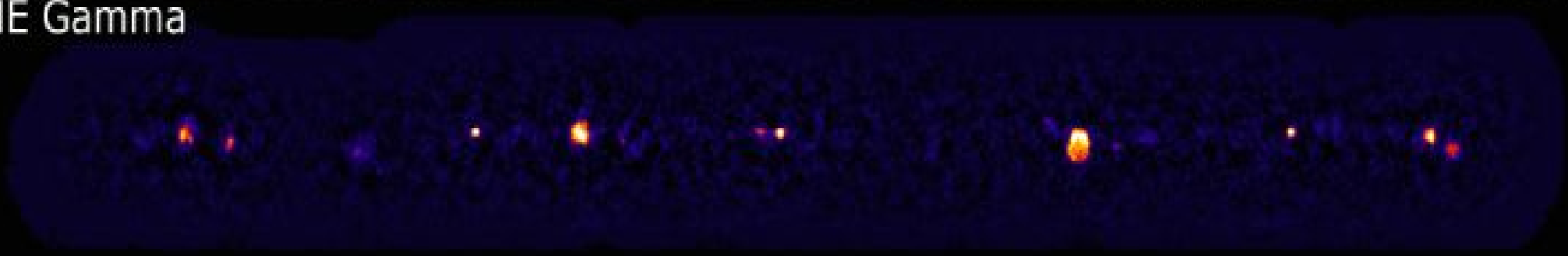
Searching for counterparts:



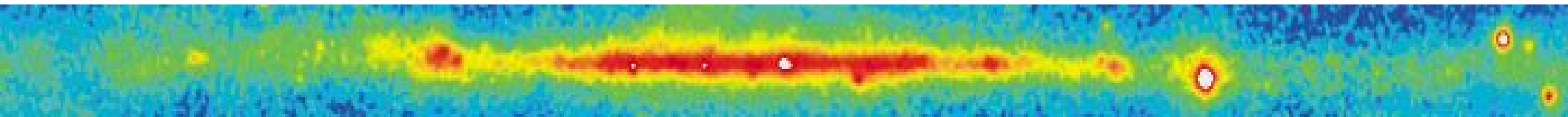
A new source is detected

Astrometry: Position, (size, morphology)

VHE Gamma



Searching for counterparts:



A new source is detected

Targeted search
(Pointed observation)
Single source

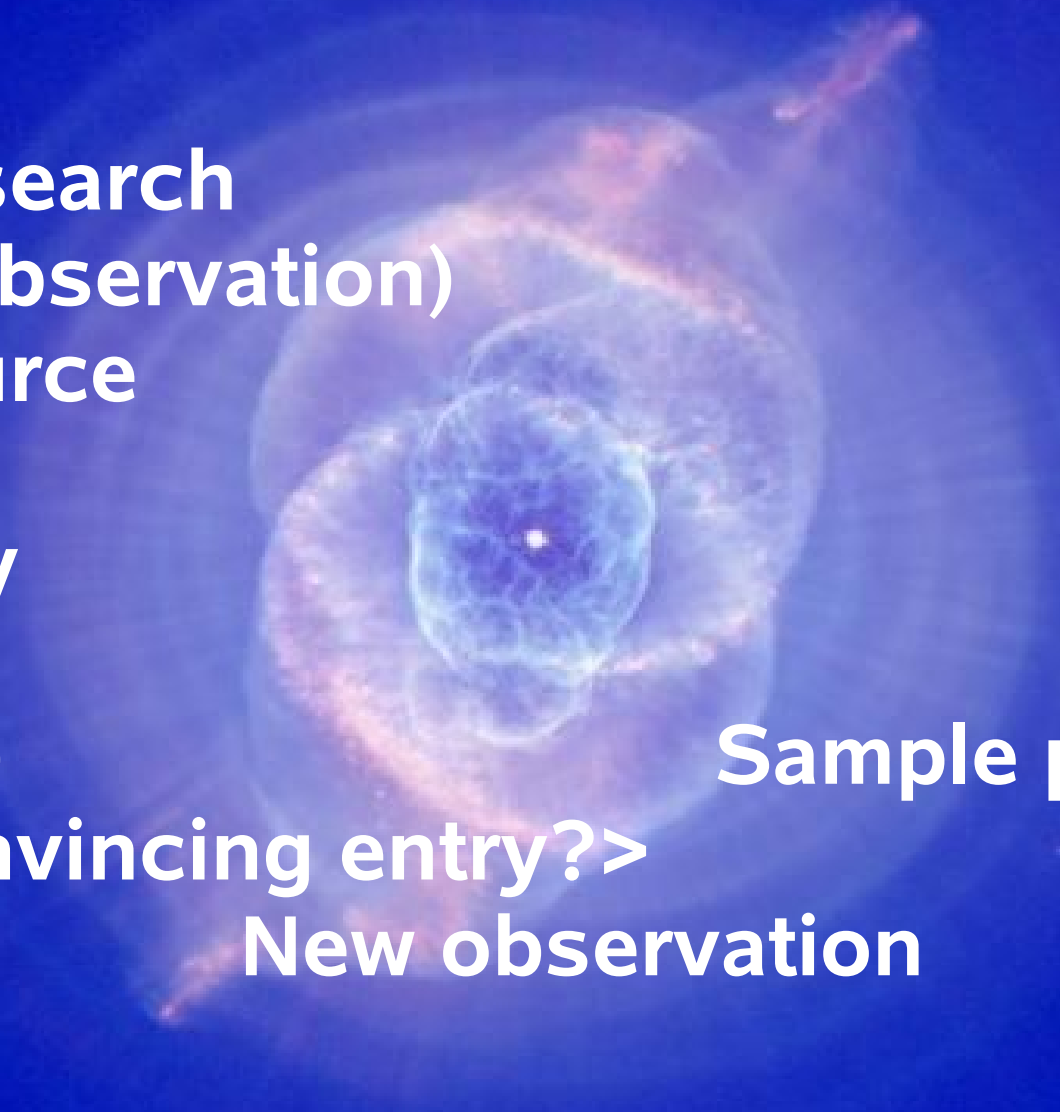
astrometry
catalogs
SED (VOs)

Sample properties

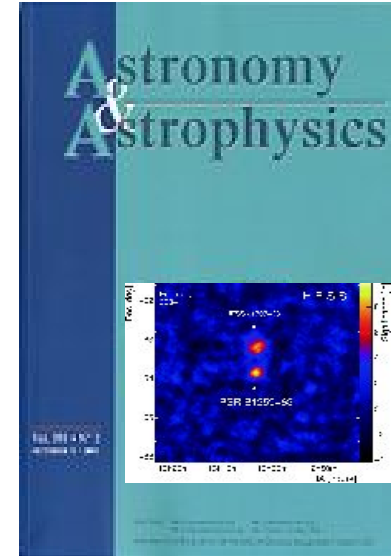
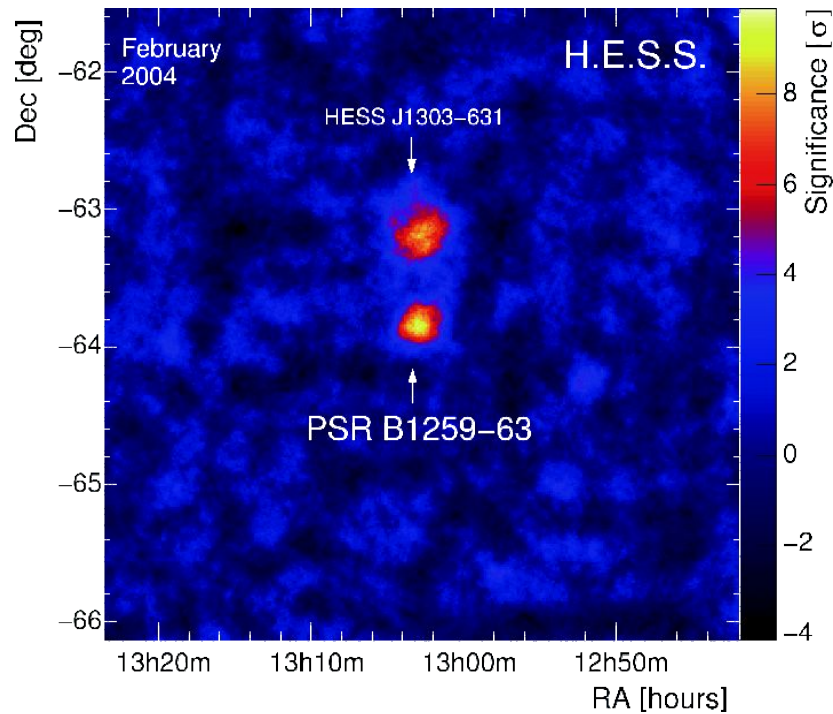
<convincing entry?>

New observation

Physics



A new source is detected



Serendipitous discoveries and sky surveys turn out new sources, e.g. HESS J 1303-631.

A lot of multiwavelength work is required for “known” sources as well, e.g. PSR 1259-63

A new source is detected

Targeted search
(Pointed observation)
Single source

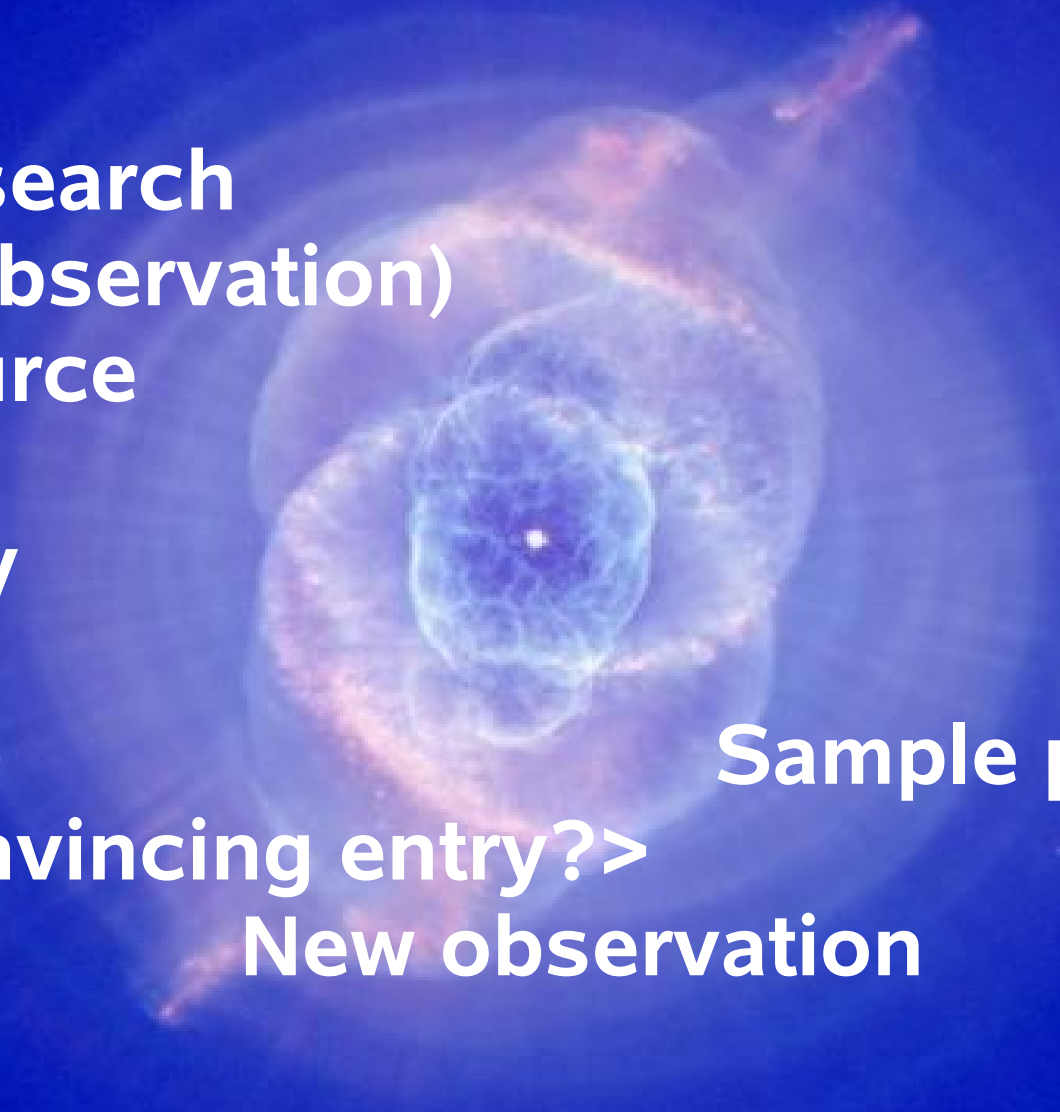
astrometry
catalogs
SED (VOs)

Sample properties

<convincing entry?>

New observation

Physics

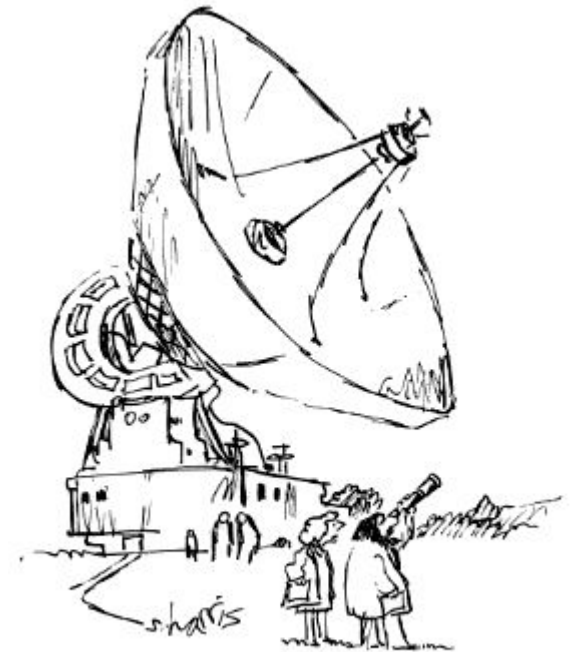


Astrometry

Astrometric accuracy and spatial resolution are extremely important for identifications based on positional coincidence.

HESS (pointing and resolution) is much better than EGRET, but much worse when compared to X-ray, optical, and radio regimes.

Gal. Center: 2000 x-ray sources consistent with TeV signal
HESS J 1303-631: 4, 40, 400 coincident sources in X-ray,
radio, and optical bands



"Just checking."



SIMBAD Astronomical Database



[CDS](#) · [Simbad](#) · [VizieR](#) · [Aladin](#) · [Catalogues](#) · [Nomenclature](#) · [Biblio](#) · [Tutorial](#) · [Developer's corner](#)

First announcement: [Simbad 4 is arriving.](#)

<i>Queries</i>
by identifier
by coordinates
by reference code
by list (file)
by criteria
by mail
Simbad mirror at CfA

<i>Documentation</i>
Presentation
Main functionalities
Content description
User's guide
Nomenclature Dictionary
Release history

<i>Information</i>
Registration
Acknowledgment
Release:
3.3 - June 2001

Content

The SIMBAD astronomical database provides basic data, cross-identifications and bibliography for astronomical objects outside the solar system.

SIMBAD can be queried by object name, coordinates, other criteria (filters), and lists of objects.

Links to some other on-line services are also provided.

Statistics

Simbad contains today (3-Oct-2005) :

3,553,465 objects

9,416,882 identifiers

160,594 bibliographical references

4,874,993 citations of objects in papers



SIMBAD Astronomical Database



[CDS](#) · [Simbad](#) · [VizieR](#) · [Aladin](#) · [Catalogues](#) · [Nomenclature](#) · [Biblio](#) · [Tutorial](#) · [Developer's corner](#)

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[Documentation](#)

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SIMBAD Query Result



[Registration](#)

[Acknowledgment](#)

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Object query : **simbad search 3C273**

⇒ Your identifier (3C273) is translated into : 3C 273

Available data:

[Basic data](#)

[Identifiers](#)

[Plot & image tools](#)

[Bibliography](#)

[Measurements](#)

[External archives](#)

Notes

Release:

3 - June 2001

Basic data : **4C 02.32 -- Quasar**

Query around with radius arc min.

ICRS 2000.0 coordinates **12 29 06.6997 +02 03 08.598 [2.84 1.78 0] A**
[1998AJ...116..516M](#)

FK5 2000.0/2000.0 coordinates **12 29 06.70 +02 03 08.6 [2.84 1.78 0]**

FK4 1950.0/1950.0 coordinates **12 26 33.29 +02 19 43.2 [366.74 175.52 112]**

Galactic coordinates **289.95 +64.36**

Proper motion (*mas/yr*) [error ellipse] **-11.01 4.38 [7.17 3.51 113] A** [1997A&A...323L..49P](#)

B magn, V magn, Peculiarities **13.07, 12.86, V**

Spectral type S...

Radial velocity (v:Km/s) or Redshift (z) **z +.158 [~] D** [2002ApJS..141...23E](#)

Parallaxes (*mas*) **3.59 [6.07] A** [1997A&A...323L..49P](#)

[Statistics](#)

lay (3-Oct-2005) :

ical references

objects in papers



SIMBAD Astronomical Database



[CDS](#) · [Simbad](#) · [VizieR](#) · [Aladin](#) · [Catalogues](#) · [Nomenclature](#) · [Biblio](#) · [Tutorial](#) · [Developer's corner](#)

First announcement: [Simbad 4 is arriving.](#)

[Queries](#)

[Documentation](#)

[Information](#)



SIMBAD Query Result



[Registration](#)

[Acknowledgment](#)

[CDS](#) · [Simbad](#) · [VizieR](#) · [Aladin](#) · [Catalogues](#) · [Nomenclature](#) · [Biblio](#) · [Tutorial](#) · [Developer's corner](#)

Object query : `simbad search 3C273`

⇒ Your identifier (3C273) is translated into : 3C 273

Identifiers (81):

Available data:

[Basic data](#)

[Identifiers](#)

[Plot & image tools](#)

[Bibliography](#)

[Measurements](#)

Basic data : **4C 02.32 -- Quasar**

ICRS 2000.0 coordinates **12 29 06.6997 +02 03 19.4**
[1998AJ....116..516M](#)

FK5 2000.0/2000.0 coordinates **12 29 06.70 +02 03 0**

FK4 1950.0/1950.0 coordinates **12 26 33.29 +02 19 4**

Galactic coordinates **289.95 +64.36**

Proper motion (*mas/yr*) [error ellipse] **-11.01 4.38 [7.17 3.5]**

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Radial velocity (v:Km/s) or Redshift (z) **z +.158 [~] D [2002A](#)**

Parallaxes (*mas*) **3.59 [6.07] A [1997A](#)**

[4C 02.32](#)
[Balloon 110607001](#)
[3C 273B](#)
[2CG 289+64](#)
[CTA 53](#)
[\[DGW65\] 56](#)
[2E 2729](#)
[1ES 1226+02.3](#)
[\[GGR94\] 1226+023](#)
[GSC 00282-00202](#)
[\[HB93\] 1226+023](#)
[HIP 60936](#)
[\[IN88\] 1226+023](#)
[JVAS J1229+0203](#)
[1Jy 1226+02](#)
[MSH 12+0-08](#)
[PG 1226+023](#)
[PKS J1229+0203](#)
[\[PUC81\] 3C 273 B](#)
[QSO B1226+0219](#)
[RORF 1226+023](#)
[1RXS J122906.5+020311](#)
[2U 1224+02](#)
[USNO 731](#)
[\[VV2003\] J122906.7+020308](#)
[\[VYP98\] 1226+023](#)
[XSS J12288+0200](#)

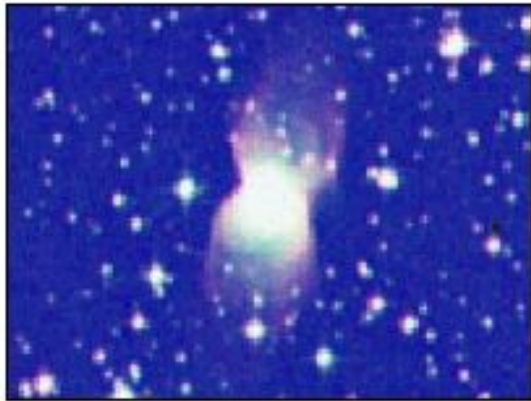
[2A 1225+022](#)
[\[BDW2002\] q1226+0219](#)
[3C 273](#)
[\[CGL99\] 11](#)
[DA 324](#)
[\[DML87\] 295](#)
[2EG J1229+0206](#)
[EUVE J1229+02.0](#)
[\[GR92\] 1226+023](#)
[H 1226+023](#)
[HE 1226+0219](#)
[ICRF J122906.6+020308](#)
[IRAS 12265+0219](#)
[JVAS B1226+023](#)
[LEDA 41121](#)
[NRAO 400](#)
[PKS 1226+02](#)
[PMN J1229+0203](#)
[QSO J1229+0203](#)
[RBS 1114](#)
[RX J1229.1+0203](#)
[\[S77\] 207](#)
[3U 1224+02](#)
[VSOP J1229+0203](#)
[\[VV96\] J122906.7+020308](#)
[\[WTW94\] 1226+023](#)
[AAVSO 1224+02](#)

[3A 1226+023](#)
[3C 273.0](#)
[1CG 291+65](#)
[3CR 273](#)
[\[DGT2001\] B1226+023](#)
[2E 1226.5+0219](#)
[3EG J1229+0210](#)
[2EUVE J1229+02.0](#)
[GRA B1226+02](#)
[1H 1226+022](#)
[HIC 60936](#)
[IERS B1226+023](#)
[IRAS F12265+0219](#)
[1Jy 1226+023](#)
[MRC 1226+023](#)
[OHIO N 044](#)
[PKS 1226+023](#)
[\[POS96\] 8](#)
[QSO B1226+023](#)
[RGB J1229.1+0203](#)
[RX J122906+02031](#)
[SIM 1226+02.0](#)
[4U 1226+02](#)
[\[VV2000\] J122906.7+020308](#)
[\[VV98\] J122906.7+020308](#)
[\[WZX98\] 12265+0219](#)
[com 3C 273B is QSO](#)

Virtual Observatories



Virtual Observatories



**Quick SkyView
Image:**

Coordinates or
Source:

Survey:

[Help](#)

SkyView is a Virtual Observatory on the Net generating images of any part of the sky at wavelengths in all regimes from Radio to Gamma-Ray.

10 August 2005: Please try the [Java-based version of SkyView](#). This new version provides a more efficient and robust geometry engine for image generation and new resampling and image processing capabilities. Not all surveys and advanced options are included at this time but they will be made available over the next several weeks.

The alternate *SkyView* server is available at skys.gsfc.nasa.gov.

**Start creating images by selecting
a *SkyView* interface.**

**See below for documentation
and other useful links.**

A new source is detected

Targeted search
(Pointed observation)
Single source

astrometry

catalogs

SED (VOs)

<convincing entry?>

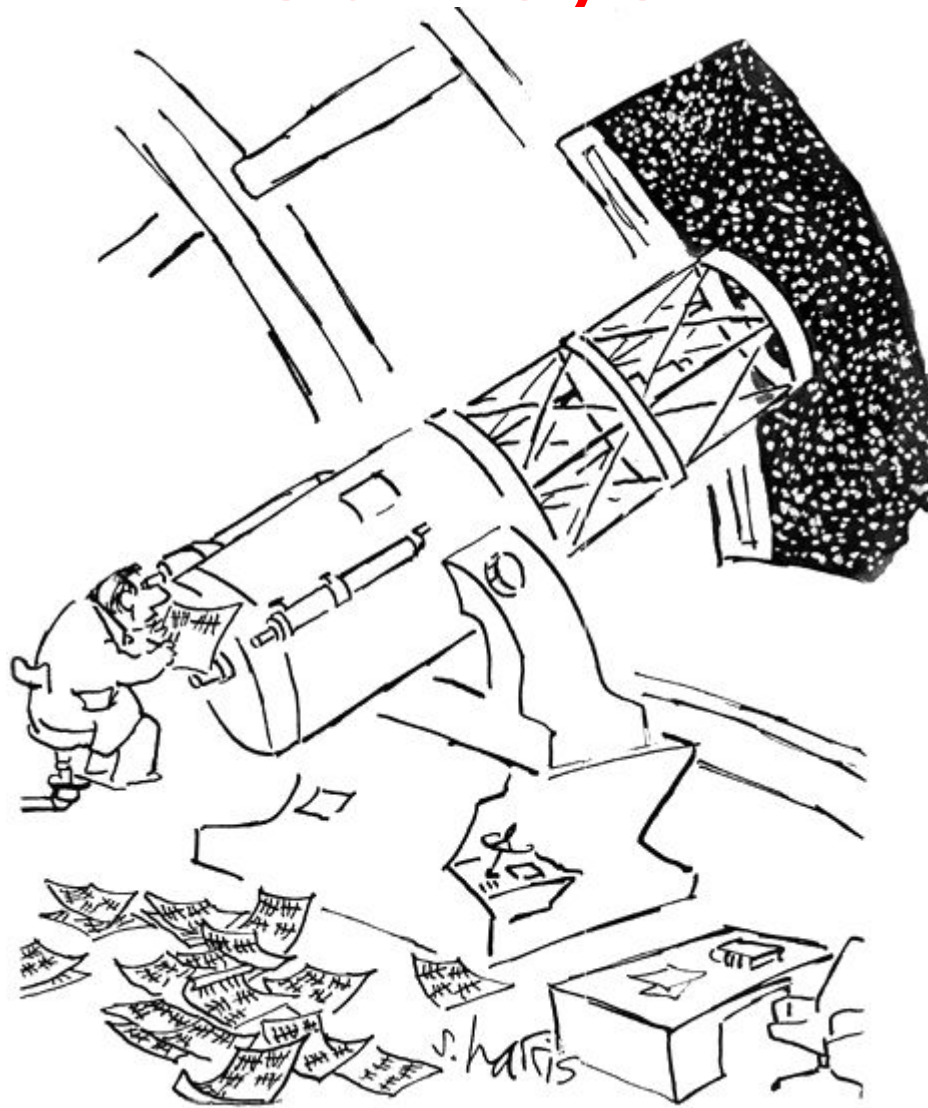
Sample properties

New observation

Physics



Surveys



A new source is detected



Survey
(All sky coverage)
Many sources

SED (VOs)

New observation

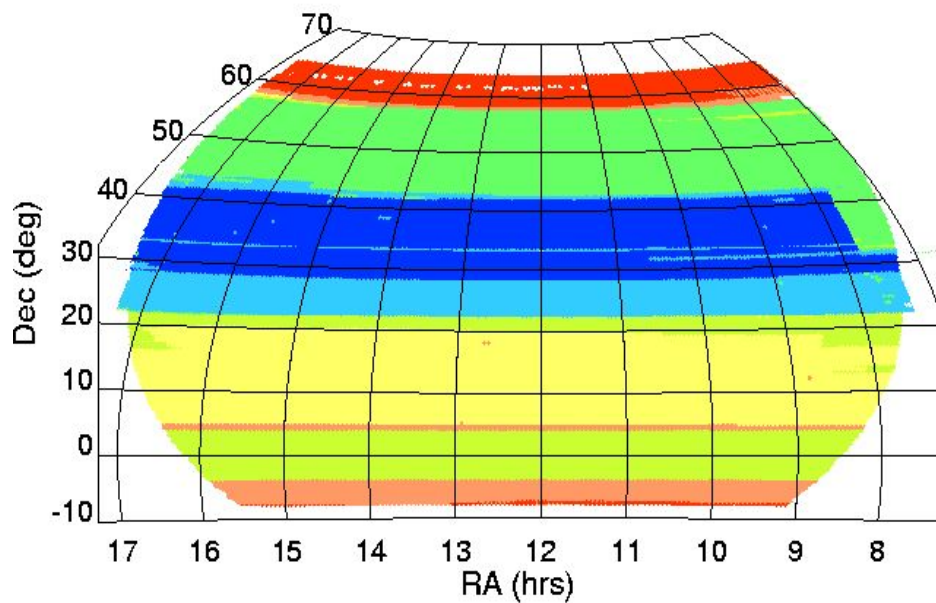
astrometry
catalogs
Sample properties
<convincing entries?>



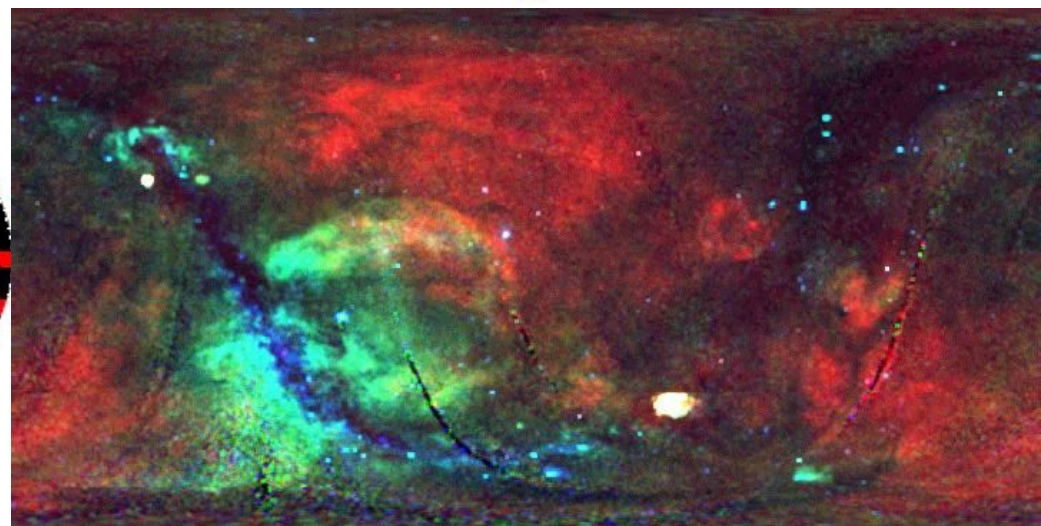
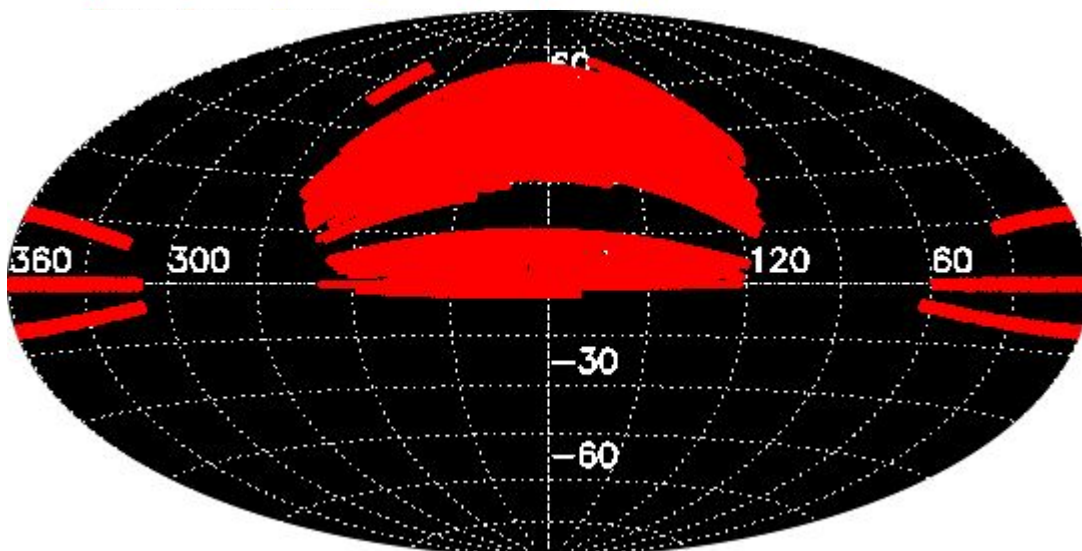
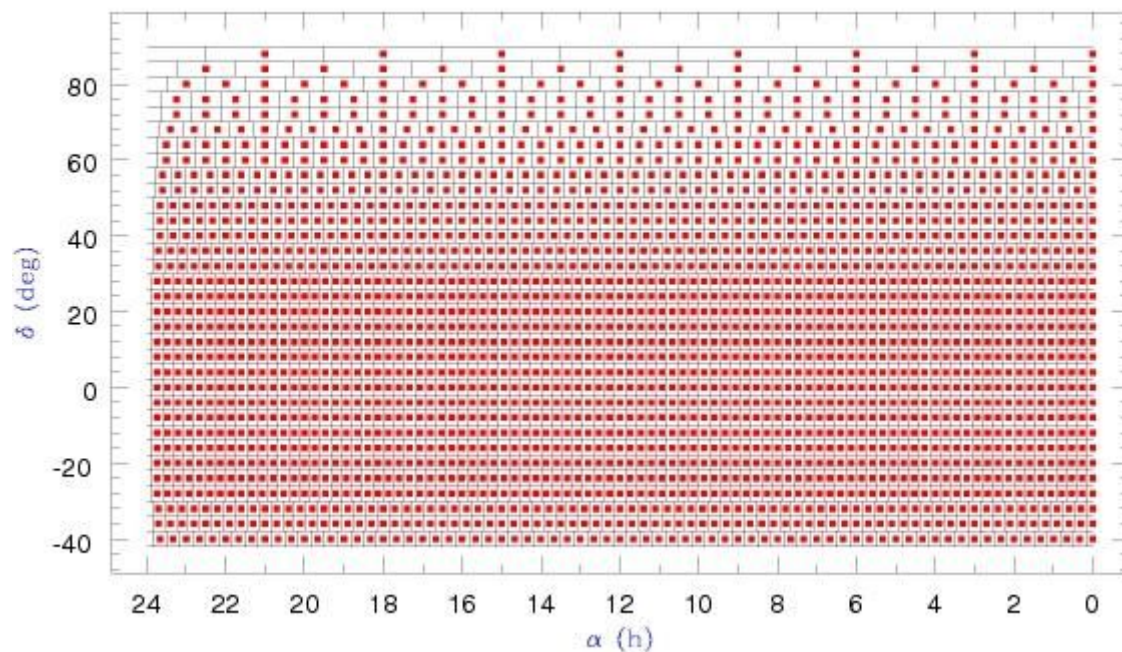
Physics

Catalogues (Surveys)

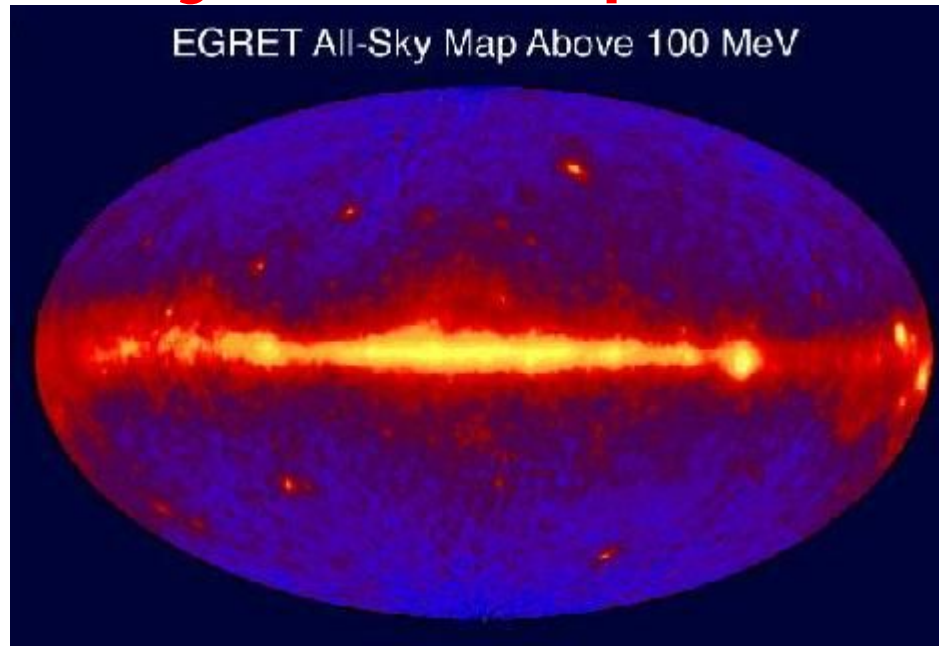
FIRST Survey Northern Sky Coverage, 2003 April 11



NVSS images currently available by FTP



An “easy” example: EGRET



End of Cycle 1 (All Sky Survey):

Galactic Plane (Diffuse, poor PSF) + ~30 point 'isotropic' sources; No (very little) evidence of previously known and identified COS-B sources.

Cross-correlation with many catalogues.
Nearly perfect match with FSRQ from 1Jy catalogue
homogeneity and completeness as essential as
rigorous statistical tests for chance coincidences

A new source is detected



Survey
(All sky coverage)
Many sources

SED (VOs)

New observation

astrometry
catalogs
Sample properties
<convincing entries?>



Physics

A new source is detected

Targeted search or Survey
Single sources or Populations

astrometry
catalogs

SED (VOs) and sample properties
<convincing entry?>

Physics

New observations

Physics:



Science Archive Facility

[SEARCH](#) [HELP](#) [FAQ](#)

The ESO/ST-ECF Science Archive is a joint collaboration of the [European Southern Observatory \(ESO\)](#) and the [Space Telescope - European Coordinating Facility \(ST-ECF\)](#).

ESO observational data can be requested after the proprietary period by the astronomical community. Please read the official ['ESO Data Access Policy'](#) statement for more information. The entire HST archive is available world-wide. To request data you have to [register as an ESO/ST-ECF Archive user](#). Please [acknowledge](#) the use of archive data in your publications.

On-Line Services

Archive User Profile	
On-line User Registration	<input type="button" value="go"/>
ESO Data	
ESO Science Archive	<input type="button" value="go"/>
Hubble Space Telescope Data	
HST Science Archive	<input type="button" value="go"/>
Catalogs & DSS	
Digitized Sky Survey	<input type="button" value="go"/>
Tools & Documentation	
ESO's Data Interface	<input type="button" value="go"/>
Related External Services	
The Vizier catalogs, CDS	<input type="button" value="go"/>
ESO & HST Image Galleries	

News and updates

- **NEW** [GOODS/ISAAC Release V1.5](#) data are now available (**30 September 2005**).
- **NEW** [XMM/WFI Survey Release](#) data are now available (**September 2005**).
- AMBER [Commissioning](#) data (MWC 297) are now available (**August 2005**).
- MIDI [Science Demonstration](#) data (Post-AGB Stars: SX Cen and HD 52961) are now available (**August 2005**).
- MIDI [Science Demonstration](#) data (SD5 Asteroids) are now available (**July 2005**).

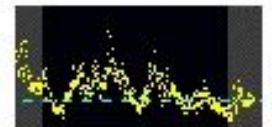
Public Datasets



Digitized Sky



Paranal Meteo



La Silla Meteo



New observations:

If data do not exist, new observations are necessary.

Most other bands are available through observatories:

Most observatories serve wide communities

(National observatories, ESO, Consortia (e.g. LBT), ESA, NASA, global open time.

Satellites, Observatories: GTO, DDT, Calibration, GO

Access via peer-reviewed proposals:

Examples: ESO (3 sites, 10 telescopes, 20 instruments, 1000 observing modes): 2 AOs/year, 1500 proposals/year,

overbooking ~4, reviewed by 50 experts, proposal-data: 1 yr

All data available in the archive 12 months after delivery.

Special proposals for surveys

Similar for satellites and other ground based facilities.



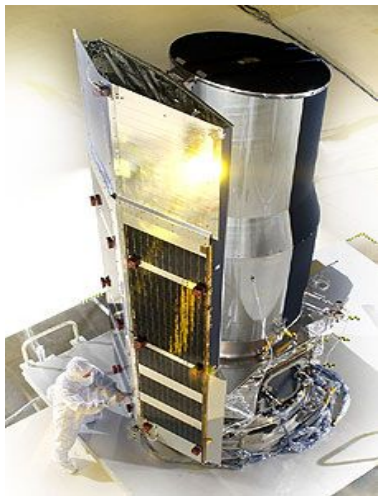
Where to go? What to do?



What do I want to know?

Choose waveband,
...requirements
...facility,
...instrument,
...mode

X-ray or radio?
depth, resolution
ESO or SALT?
high-res. spectra or narrow-band imaging?
filter, camera, detector, op.mode



Where to go? What to do?

Write observing proposal

Understand documentation; write science case, justify all of the above, demonstrate feasibility and expertise

Submit (in time) and hope...

Prepare observations in more detail (satellites) or observe yourself (many groundbased facilities)
analyse data !!!

Is this signal or noise?

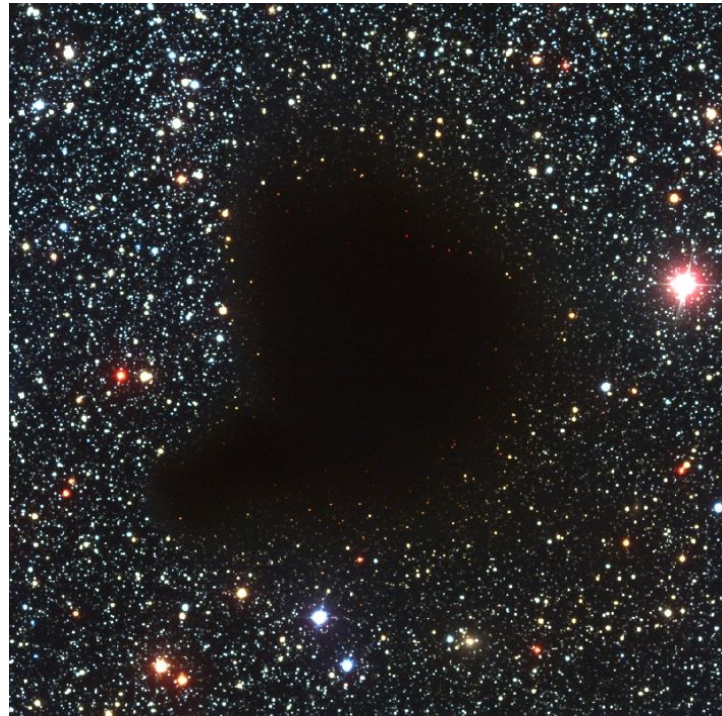
MWL is new (but 'classic') astrophysics.
It s mandatory to understand the accelerators.

Any claim for new physics needs to discriminate against
'conventional' explanations.

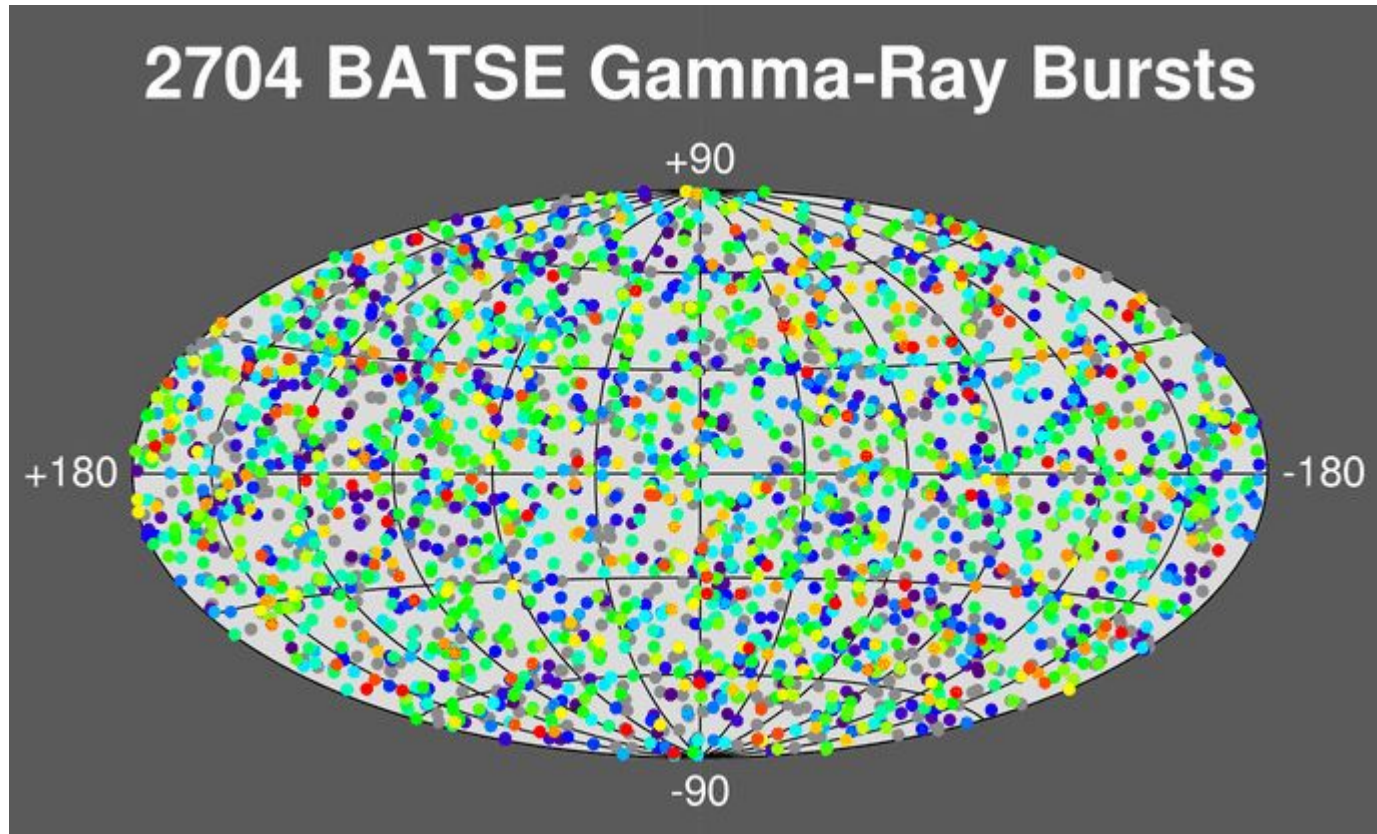
Is this signal or noise?

MWL is new (but 'classic') astrophysics.
It's mandatory to understand the accelerators.

Any claim for new physics needs to discriminate against
'conventional' explanations.



Variable sources



No steady counterparts

Incompleteness cannot be cured!

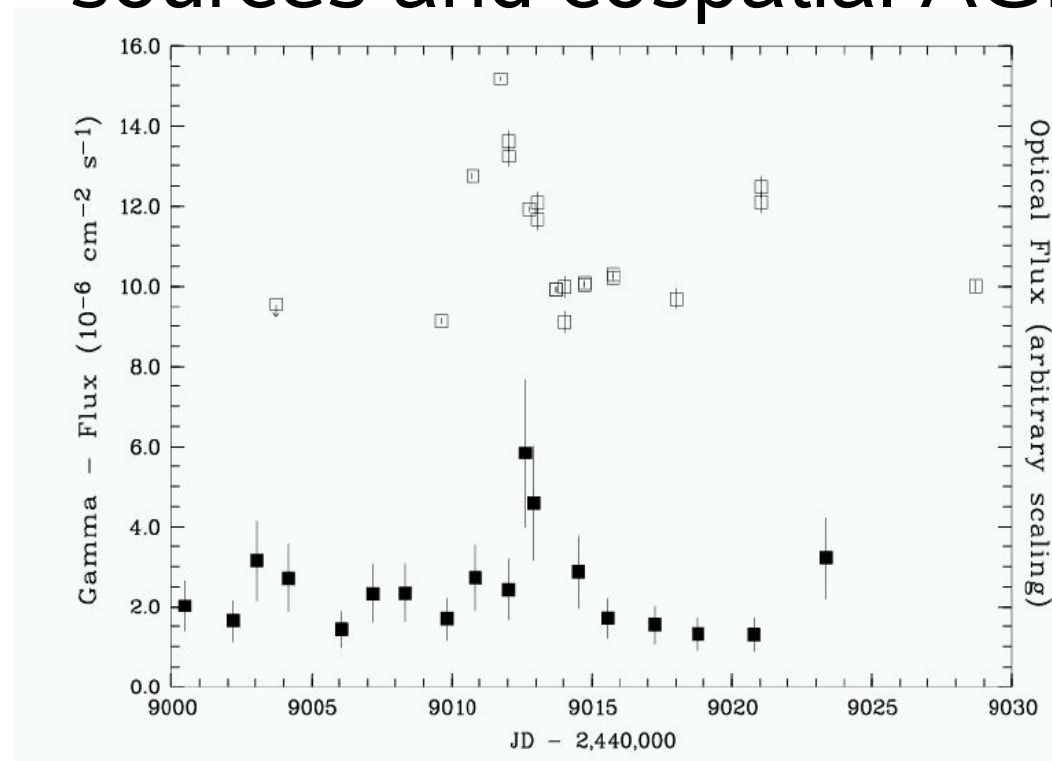
Contemporaneous measurements indispensable.

Identification simple (phase space), Resolution, Background
but beware of timing (remember the neutrinos from 1987A)

Simultaneous observations

Identification and physics facilitated by variability

Identification: e.g. simultaneous flares of EGRET sources and cospatial AGN



Physics: Radiation processes, magnetic fields constrained by simultaneous MWL data

Simultaneous observations

Many other issues (GRBs, Sne) in
time-resolved astrophysics

requiring special treatment
(and thus cannot be discussed here)

HESS-MWL has a GRB expert-team
(being alerted to internet-based information)

HESS-MWL has TOO projects to
many transient sources

Multiwavelength working group

Searching archives for ID of new sources

Obtain MWL information: a) Archives

b) New data

- Cooperation

Not discussed in much detail here:

See HESS-MAGIC studies (Goebel)

- Application

- Analysis

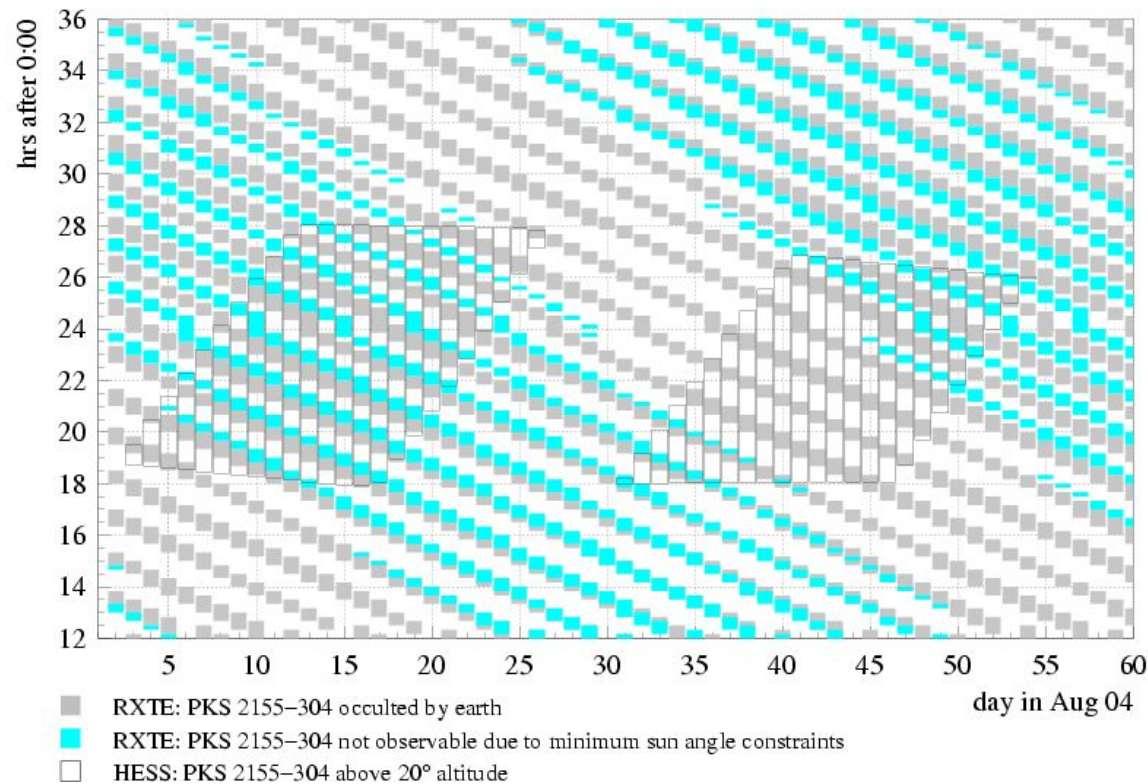
Organize simultaneous observations

Simultaneous observations

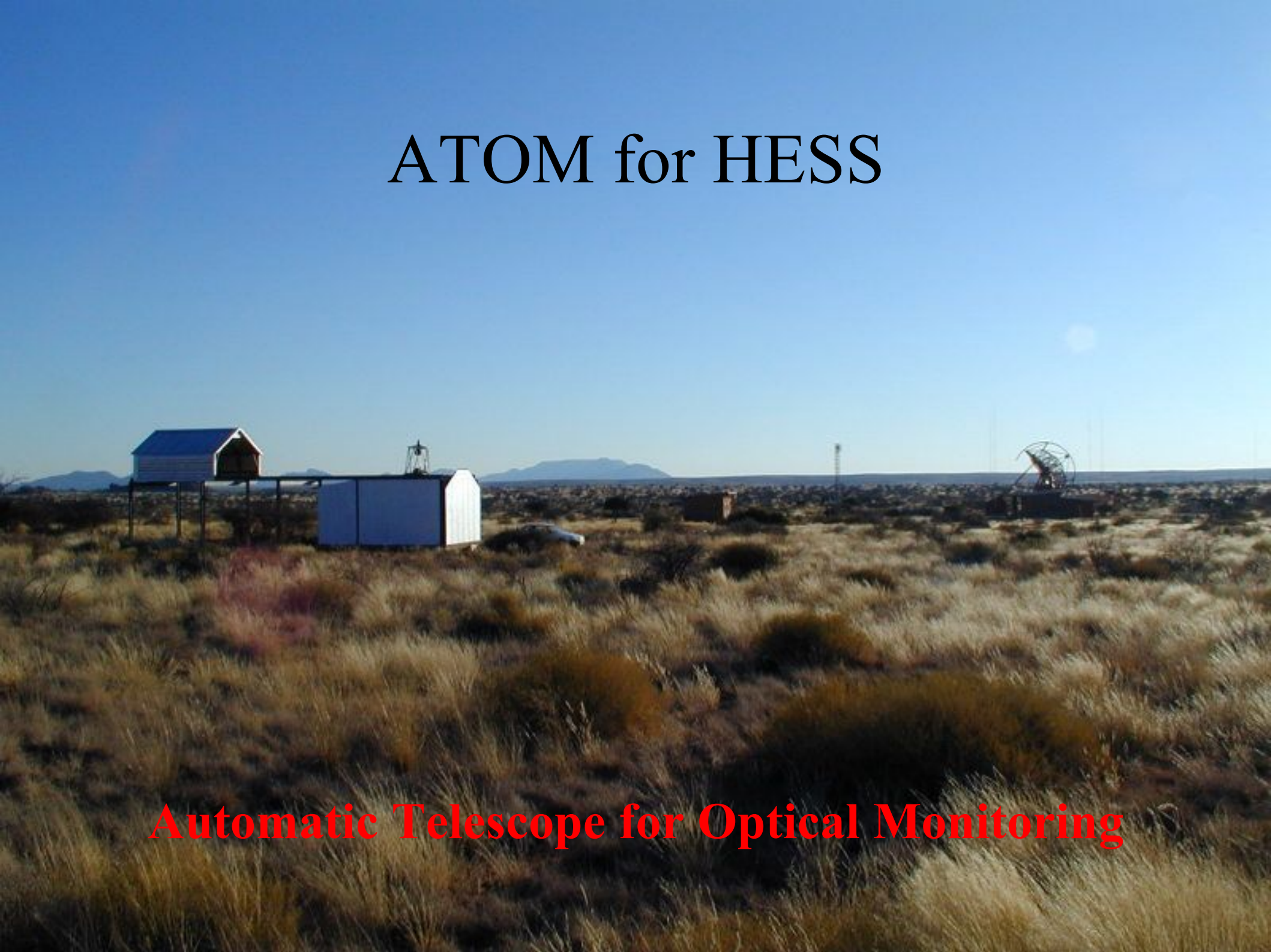
Simultaneous observations are required to understand physics questions.

Further complications in case of incomplete exposure:

white areas are possible RXTE observation windows for PKS 2155–304



ATOM for HESS



Automatic Telescope for Optical Monitoring

The ATOM project

A 75 cm telescope dedicated to HESS support

Strictly simultaneous observations of (potentially) variable HESS sources (i.e. compact galactic sources, GRB, AGN). Operations in slave mode (controlled by HESS DAQ) guarantee simultaneous MWL data.

Observations in several filters (spectral indices)

Provides monitoring of atmospheric extinction

Provides TOO triggers in idle HESS time

Main Message: MWL is important

Remember the story of the blind men:

When being guided to an elephant, they all studied that part of the animal that was right in front of them, trying to guess the nature of the beast...



... and they could neither agree nor understand.