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)

Searching for counterparts:
A new source is detected

Astrometry: Position, (size, morphology)

Searching for counterparts:
A new source is detected

Targeted search
(Pointed observation)
Single source

astrometry
catalogs
SED (VOs)

<convincing entry?>
Sample properties
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
A new source is detected.
A new source is detected

SIMBAD Query Result

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

Basic data: 4C 02.32 -- Quasar

ICRS 2000.0 coordinates 12 29 06.6997 +02 03 08.598 [2.84 1.78 0] A

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


B mag, V mag, Peculiarities 13.07, 12.86, V

Spectral type S...

Radial velocity (v:Km/s) or Redshift (z) z +1.158 [~] D 2002ApJS..141...23E


Statistics

played (3-Oct-2005):

objects in papers
SIMBAD Query Result

Object query : simbad search 3C273

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

Identifiers (81):

Basic data : 4C 02.32 -- Quasar

ICRS 2000.0 coordinates 12 29 06.6997 +02 00.0

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 0

Galactic coordinates 289.95 +64.36

Proper motion (mas/yr) [error ellipse] -11.01 4.38 [ 7.17 3.9]

B mag, V mag, Peculiarities 13.07, 12.86, V

Spectral type S...

Radial velocity (v:Km/s) or Redshift (z) z +158 [-] D 2002A

Parallaxes (mas) 3.59 [6.07] A 1997A

Available data: Basic data Identifiers Plot & image tools Bibliography
Virtual Observatories
Virtual Observatories

*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](http://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)

Sample properties
<convincing entry?>

New observation

Physics
Surveys
A new source is detected

Survey
(All sky coverage)
Many sources

astrometry catalogs
Sample properties
<convincing entries?>

SED (VOs)
New observation

Physics
Catalogues (Surveys)
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

astrometry catalogs

Sample properties <convincing entries?>

New observation

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

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
    - go
- ESO Data
  - ESO Science Archive
    - go
- Hubble Space Telescope Data
  - HST Science Archive
    - go
- Catalogs & DSS
  - Digitized Sky Survey
    - go
- Tools & Documentation
  - ESO's Data Interface
    - go
- Related External Services
  - The Vizier catalogs, CDS
    - go
- ESO & HST Image Galleries

News and updates

- GOODS/ISAAC Release V1.5 data are now available (30 September 2005).

- 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 ground-based 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 indispensible.
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 are required to understand physics questions.

Further complications in case of incomplete exposure:
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.