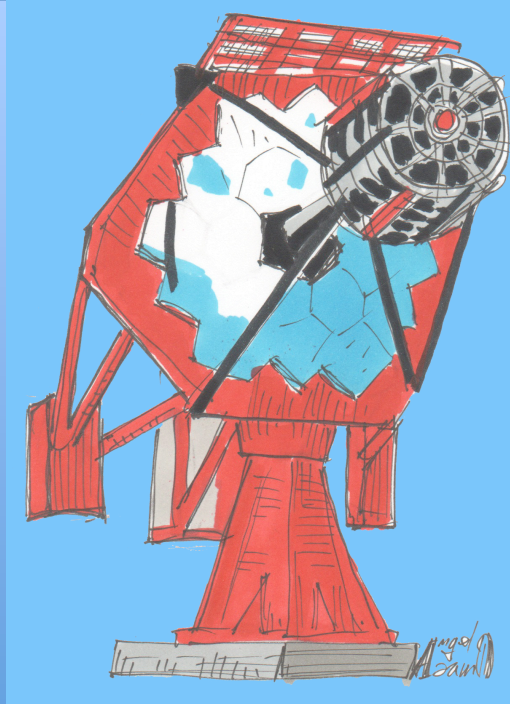
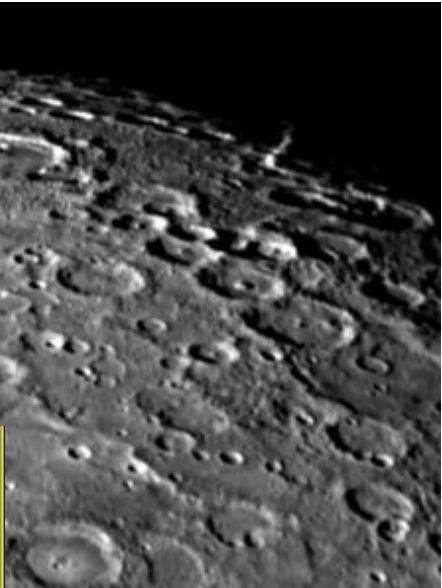
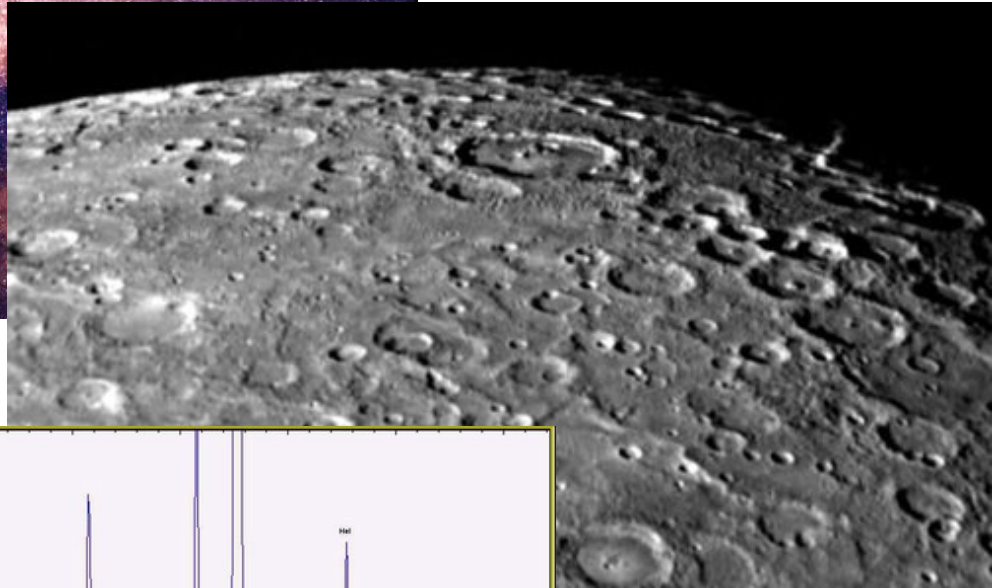


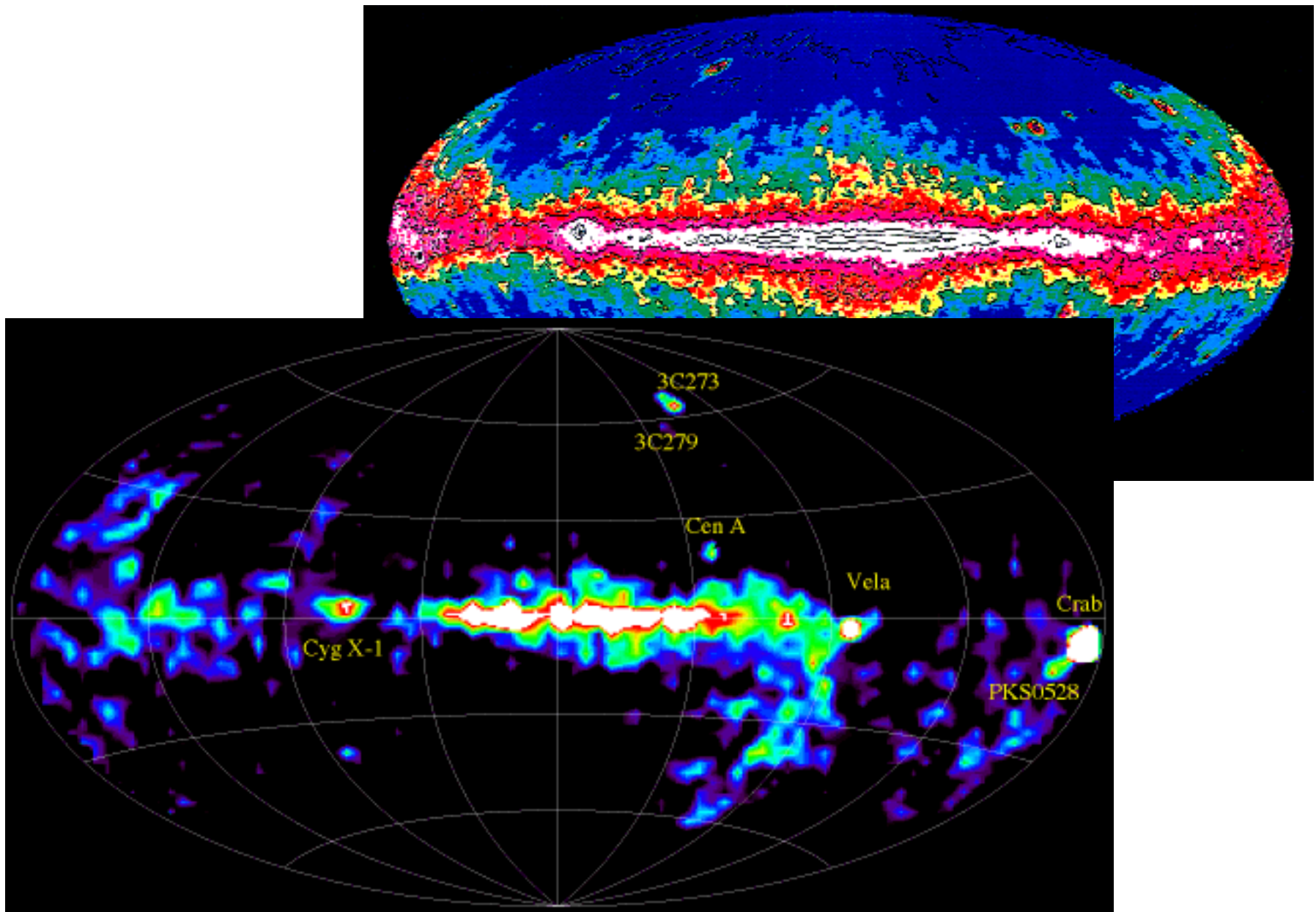
# Some aspects of pattern recognition in the context of citizen science

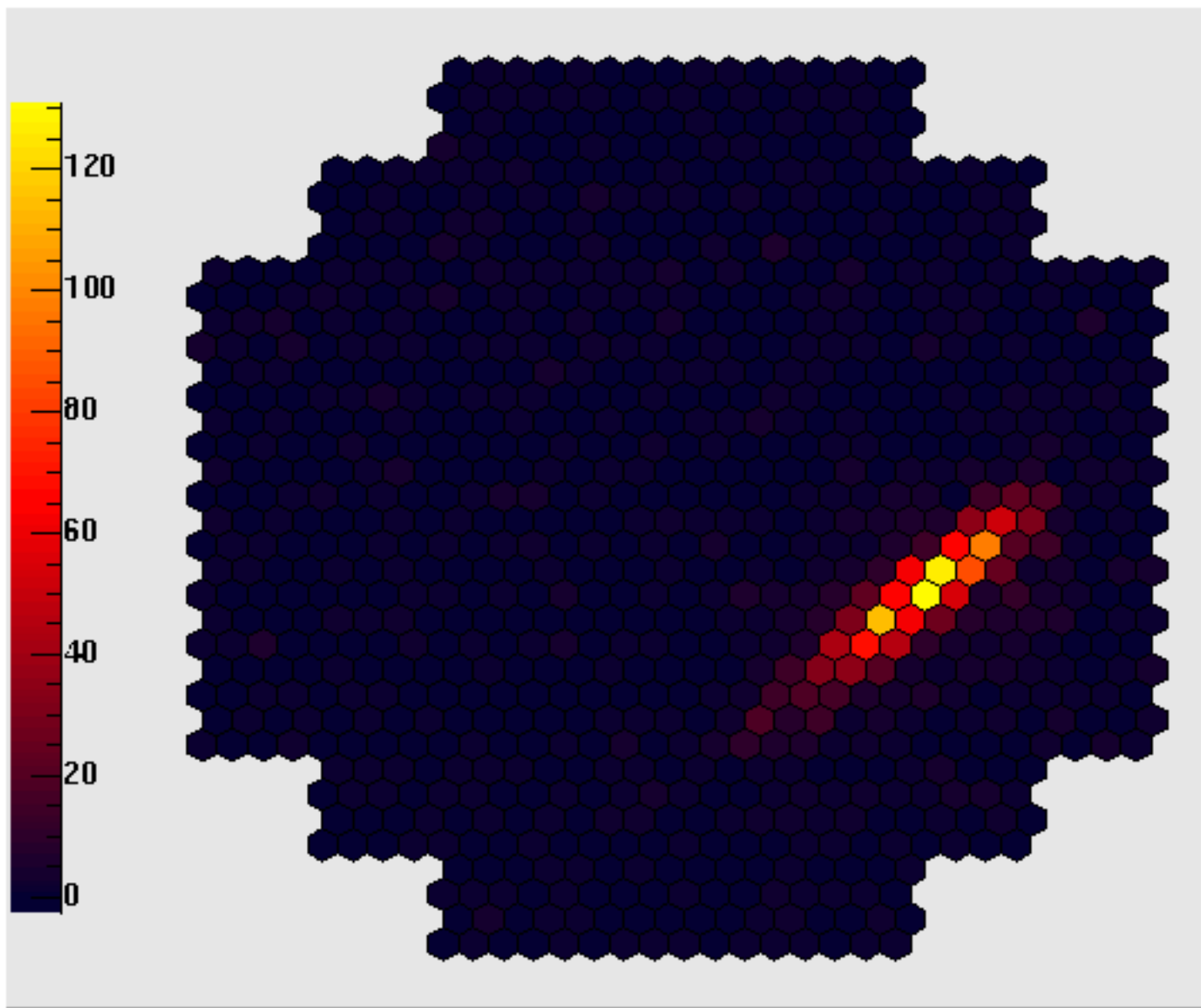


Angelo Adamo. INAF - Bologna Astronomical Observatory (IT) – Uninsubria, Como (IT)  
CREDO Inauguration Meeting, Tuesday, August 30<sup>th</sup> 2016, Krakow

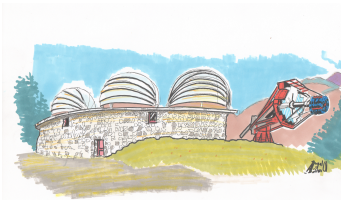




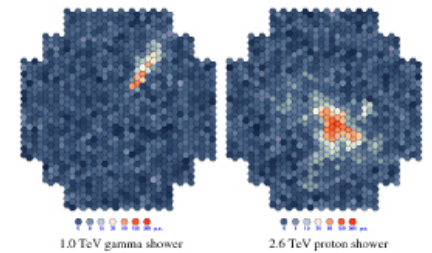
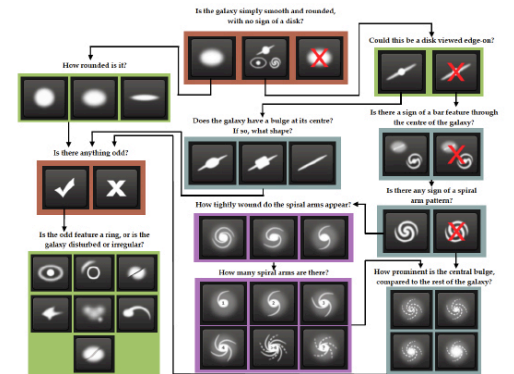
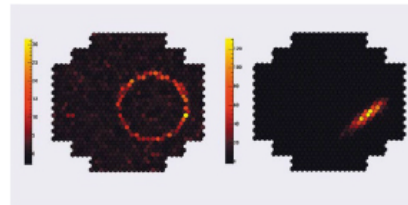
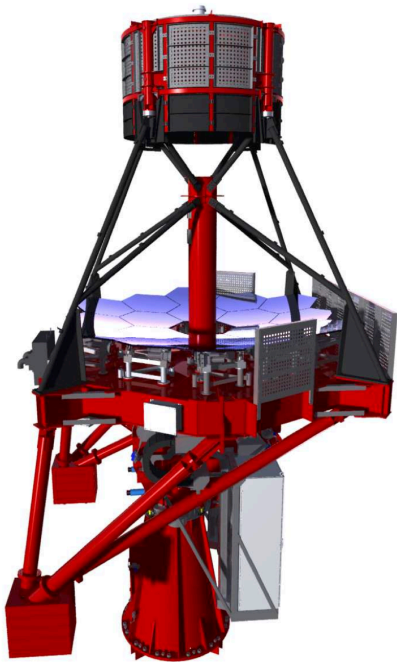
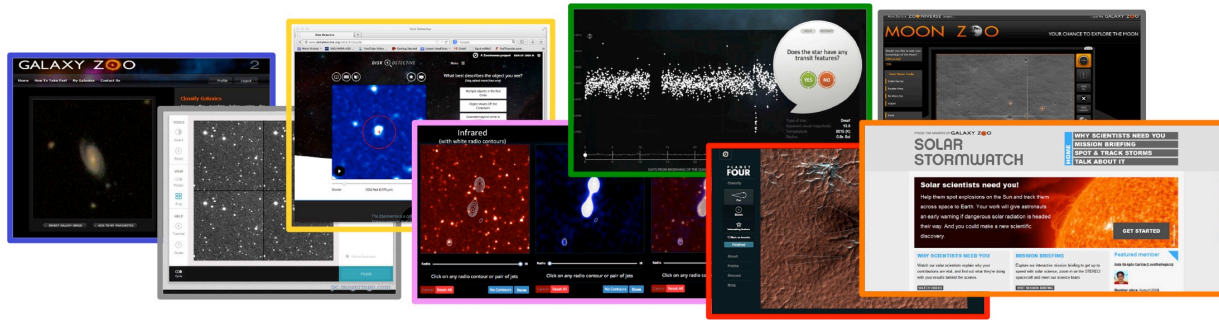


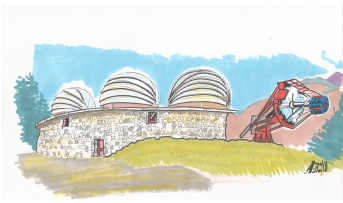






# CHEREN-ZOO





*Active learning:*

*CHEREN-ZOO*

*Intensity of the Image*

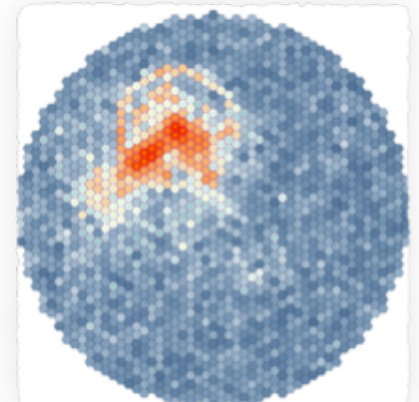
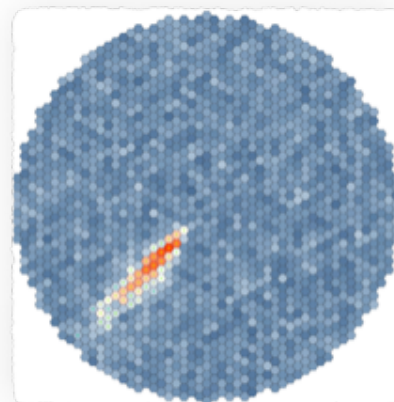
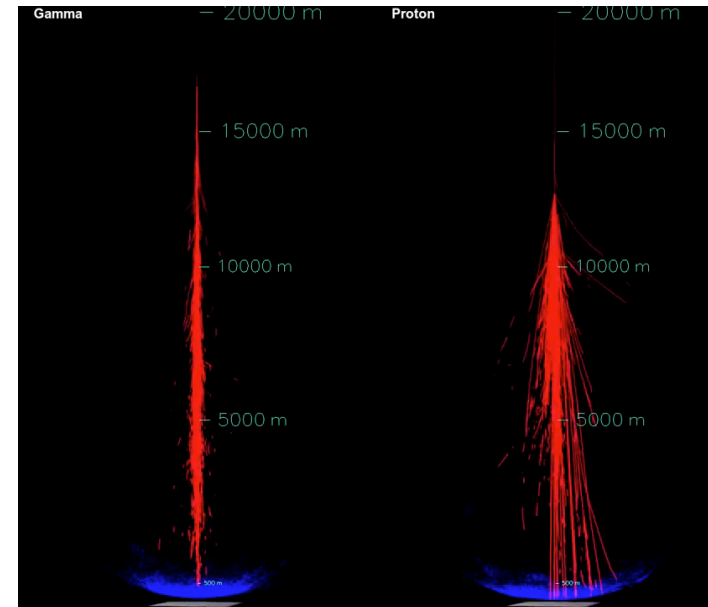
↳ *Shower Energy*

*Orientation of the image*

↳ *Shower Direction*

*Image Shape*

↳ *Particle type*



# Laboratory for High Energy Astrophysics

## Office of Guest Investigator Programs

# SAS-2

## Calibration Guide

# SAS-2 CALIBRATION

# GUIDE

Paul Barrett, Brendan Perry,  
& Ian M George  
Code 668,  
NASA/GSFC,  
Greenbelt, MD 20771

Version: 1995 Feb 24

## LOG OF SIGNIFICANT CHANGES

The post-flight selection of events was based on the following criteria. The detection of an inverted Y or V shape in one orthogonal view of the spark-chamber, and the elimination of single-track events or those intersecting the wall. After the event being accepted, its direction and energy were determined. The determination of event direction was based on a weighted bisector method: the direction was weighted toward the higher energy electron or positron. Details of this method can be found in Fichtel *et al.*(1972). The arrival direction is first determined in space-craft coordinates (altitude-azimuth), and then using the space-craft's attitude data, the celestial coordinates are determined.

The energy calculation is based on multiple Coulomb scattering of pair electrons in the tungsten plates. A description of this formalism is given by Pinkau (1966, 1968) and Kniffen (1969). The accuracy of measuring the scattering angle limits the maximum measurable energy, since higher

### 2.2.2 Human Selection

About 10% of events are considered marginal, based on the automated-selection criteria. Humans are then used to select those events which are  $\gamma$ -rays, by viewing the two orthogonal views of the spark-chamber on a graphics terminal. If the event is accepted then the direction and energy are determined using the automated selection software.

Derdeyn, S.M., Ehrmann, C.H., Fichtel, C.E., Kniffen, D.A. & Ross, R.W. 1972, *Nucl. Instr. & Methods.*, **98**, 557.

Fichtel, C.E., Hartman, R.C., Kniffen, D.A. & Sommer, M. 1972, *Astrophys. J.*, **171**, 31.

Fichtel, C.E., Hartman, R.C., Kniffen, D.A., Thompson, D.J., Bignami, G.F., Ögelman, H., Özel, M.E. & Tümer, T. 1975. *Astrophys. J.*, **198**, 163.

Kniffen, D.A., 1969, *NASA Tech. Report TR R-308*.

Pinkau, K. 1966, *Zs.f. Phys.*, **96**, 163.

Pinkau, K. 1968, Max-Planck-Institut preprint.

## Chapter 3

## POTENTIAL PROBLEMS

### 3.1 Earth Albedo

(Source: Marvin 1978)

One of the major problems with  $\gamma$ -ray astronomy is the interaction of cosmic-rays with the Earth's atmosphere producing high energy  $\gamma$ -rays. Most of these events were rejected and not included in the database, because the zenith angle (the angle between the estimated  $\gamma$ -ray direction and the zenith (the spacecraft pointing direction)) was  $> 90^\circ$ , implying their direction is near the Earth's horizon.

During the creation of the SAS-2 2 database, the STDGTI (standard good-time-interval) and ALLGTI (all good-time-interval) were determined from the spacecraft orbital data using the following criteria:



un periodo di 10 giorni presso l'osservatorio MAGIC,  
un'attività formativa rivolta agli insegnanti, come i  
poster.

# STUDENTI A LA PALMA

STUDIO

ATTIVITÀ PRATICHE

**Riconoscimento visivo dei segnali gamma:** il segnale gamma raccolto da MAGIC è estremamente raro (meno dello 0.01%) rispetto al background. Durante lo stage i ragazzi tentano di riconoscere ad occhio questi segnali, cercando di dare una stima della luminosità della sorgente, approfondendo poi i concetti di *selezione* e di *rumore di fondo*.

atmosferiche offerte dall'osservatorio, una notte di osservazione del cielo luminoso!



**Caffè MAGICO:** uno specchio da un metro quadrato si può rivelare estremamente curioso, se ad utilizzarlo sono dei giovani studenti! Dopo dettagliati calcoli, ottimistiche previsioni e fortuite soluzioni, uno specchio di MAGIC è stato "reinventato" per preparare del caffè convogliando la luce del sole verso una moka! Ne è uscito il caffè più soddisfacente dell'isola!!



**Misura del raggio terrestre:** sulle rive dell'oceano, è possibile appassionarsi delle meraviglie della natura anche calcolando la lunghezza del raggio terrestre. Bastano delle semplici triangolazioni e l'utilizzo del corpo umano come unico strumento!



**Misura distanza Terra-Luna:** è stata utilizzata la posizione relativa della Luna rispetto alle stelle, catturata da fotografie digitali, per misurare la distanza Luna-Terra. Questa misura è stata effettuata

ATTIVITÀ

Attività formativa  
Faraldo del  
Antonio Sc  
Padova da  
didattico p  
trasversale  
Realizzata  
Dott. V. Sc

Lo scopo è  
approfondire  
contatto dir

Il progetto  
studenti, è  
esso vuole  
sperimenta  
d'integrazion  
introdurre  
fisica di fro

Lo scopo è  
fare" ricerca  
Si vuole c  
specifico pe  
- lo svecchi  
- l'apprend

MAGIC  
Major Atmospheric  
Gamma Imaging  
Cosmic Telescope

arie, nell'isola  
ita molti altri

telescopio  
on fa delle  
o la luce  
ti celesti.  
rvare la  
emessa da  
ni, che è  
Per farlo  
cariche  
nell'alta  
sti raggi,  
debole  
stica (per  
to come  
vicino al  
MAGIC (17  
rivelatori  
li pixel (i

Realizzata  
Dott. V. Sc

Gamma  
Ray  
Bursts

orizzonte gamma  
cosmologico

enti alla nostra  
SuperNova, i  
lattiche (Nuclei  
e, grazie alla sua  
pare con i satelliti  
re fenomeni  
Gamma (Gamma Ray  
atteristiche più  
la natura della

Email: [magic@nd.info.it](mailto:magic@nd.info.it)  
[nd.it/index.php?id=505](http://nd.it/index.php?id=505)  
[base1.wikispaces.com](http://base1.wikispaces.com)  
[98123103331&ref=ts](http://98123103331&ref=ts)  
udenti alle Canarie alla  
rs/scalz8/Conferences/  
CoFis2010/

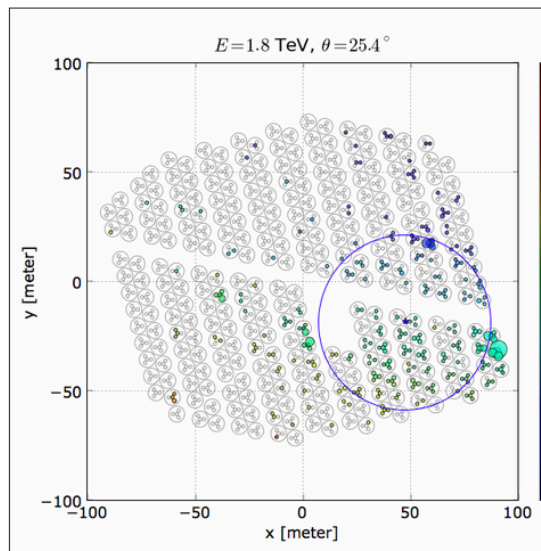


### The Gamma/Hadron Separation Game!

Play this game to see how well you can distinguish events created by gamma rays and cosmic rays in the detector. (See [Instructions](#).)

0/0 gamma-ray showers tagged so far

0/0 proton showers tagged so far



Is this a gamma-ray or a proton event?

It's a gamma-ray shower

It's a proton shower

#### Instructions

A simulated event is shown in the plot. Try to guess whether or not the event was caused by a gamma ray or a cosmic ray. The colors show the relative timing of the hits within the event (blue=early, red=late), and the marker sizes indicate the number of photoelectrons (PEs) in each channel. Large markers mean that a channel was hit by many photons due to a very large ground signal.

To identify cosmic rays, you should look for hard-hit channels far from the reconstructed shower core, which is shown as a blue star in the center of a 40-meter blue circle. Isolated hits indicate penetrating particles in the shower, a hallmark of cosmic-ray events.

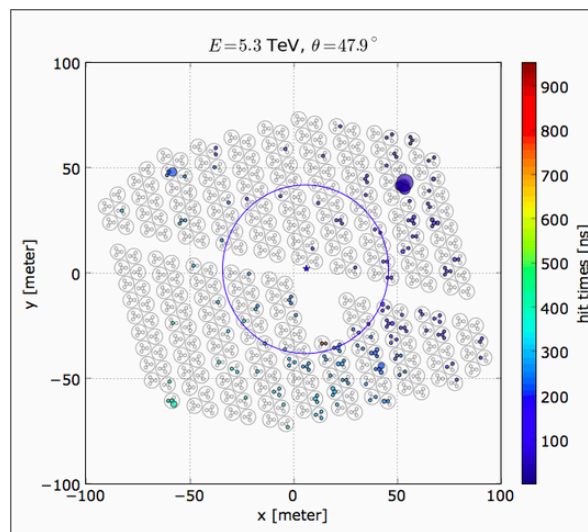
### The Gamma/Hadron Separation Game!

Play this game to see how well you can distinguish events created by gamma rays and cosmic rays in the detector. (See [Instructions](#).)

**Correct! That last one was a proton.**

0/0 gamma-ray showers tagged so far

1/2 proton showers tagged so far



Is this a gamma-ray or a proton event?

It's a gamma-ray shower

It's a proton shower

#### Instructions

A simulated event is shown in the plot. Try to guess whether or not the event was caused by a gamma ray or a cosmic ray. The colors show the relative timing of the hits within the event (blue=early, red=late), and the marker sizes indicate the number of photoelectrons (PEs) in each channel. Large markers mean that a channel was hit by many photons due to a very large ground signal.

To identify cosmic rays, you should look for hard-hit channels far from the reconstructed shower core, which is shown as a blue star in the center of a 40-meter blue circle. Isolated hits indicate the presence of penetrating particles in the shower, a hallmark of cosmic-ray events.



#### Quick Links:

##### News

- Latest news from HAWC
- [Like](#) [Share](#)
- [Follow @HAWC\\_Obs](#)

##### TeV Astronomy

- Catalog of TeV Sources
- TeV Review Papers

##### Milagro Links

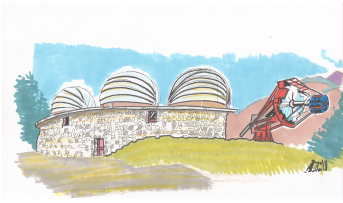
- Milagro γ-Ray Observatory
- Milagro Publications

##### For HAWC Collaborators

- HAWC Star Chart
- HAWC Internal Pages

#### Local Weather:



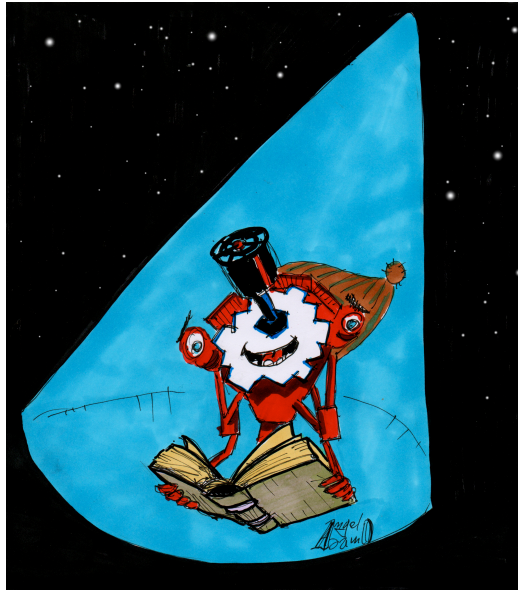


Different strategies to involve people:

## Narrative approach to very young people (but not only to them...)

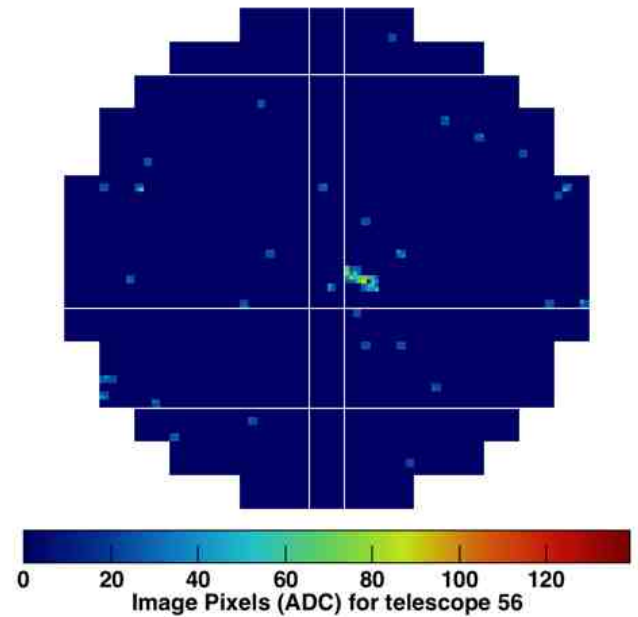
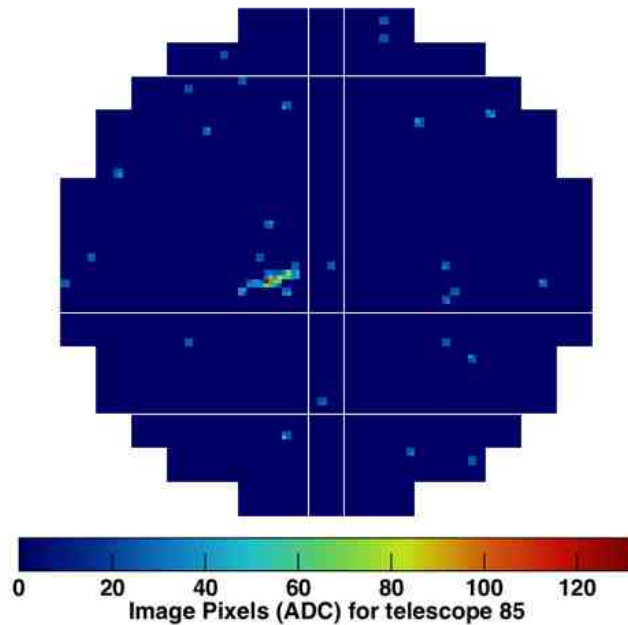
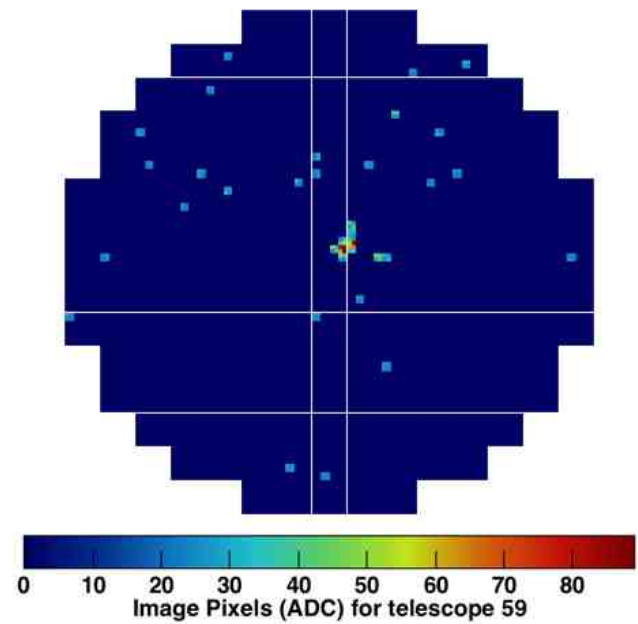
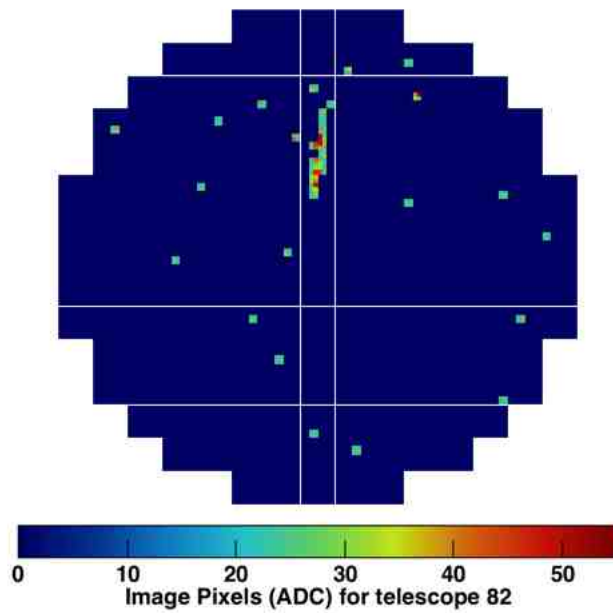
Scientific elements masked, hided behind funny and interesting characters and stimulating situations.

No need of explaining always everything to everyone. Fairy tales and the myth demonstrate the utility of teaching something without specifying the real meaning behind narration

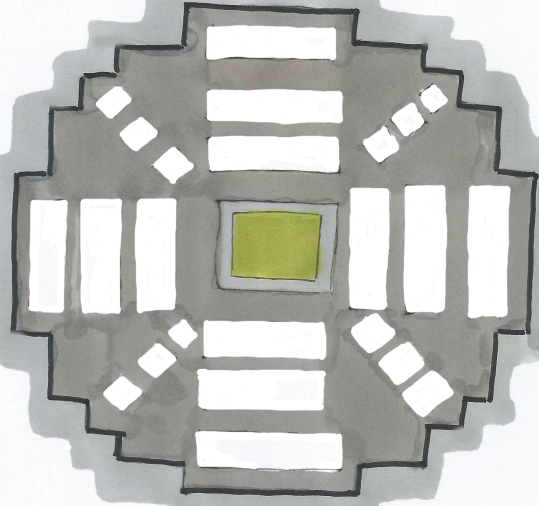
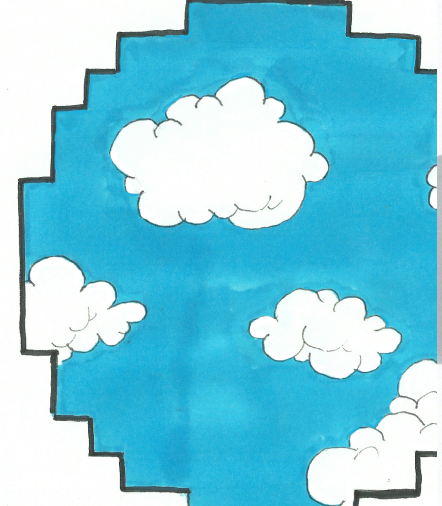
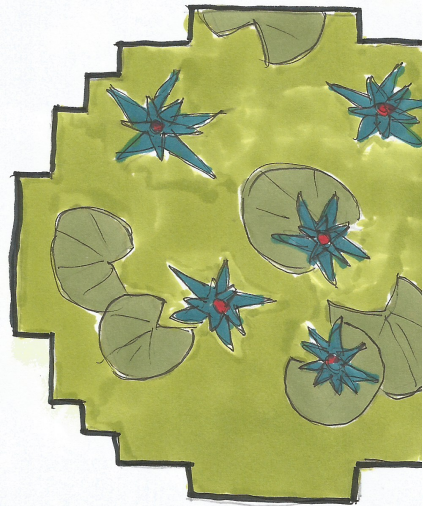
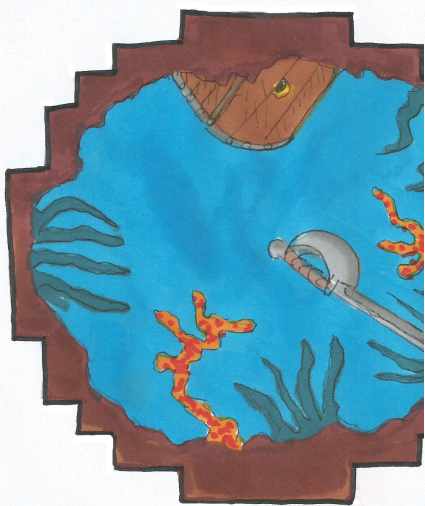
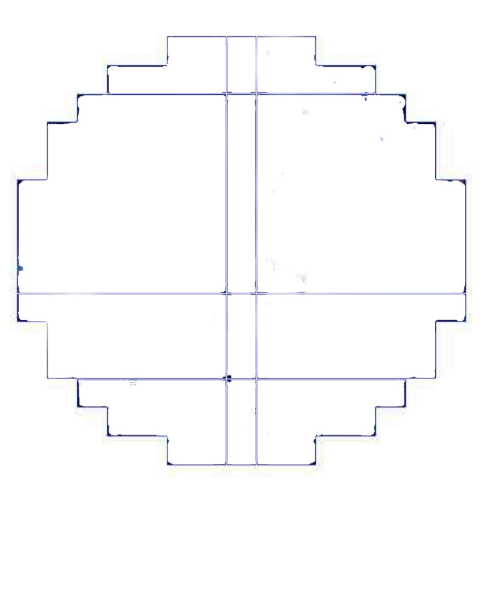
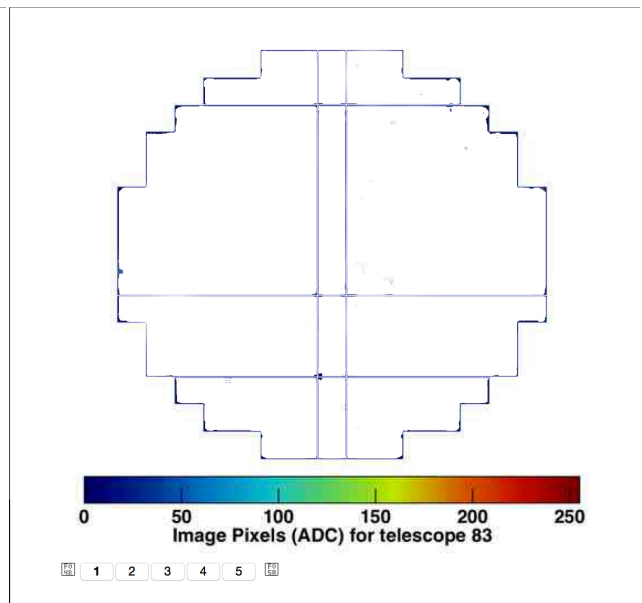
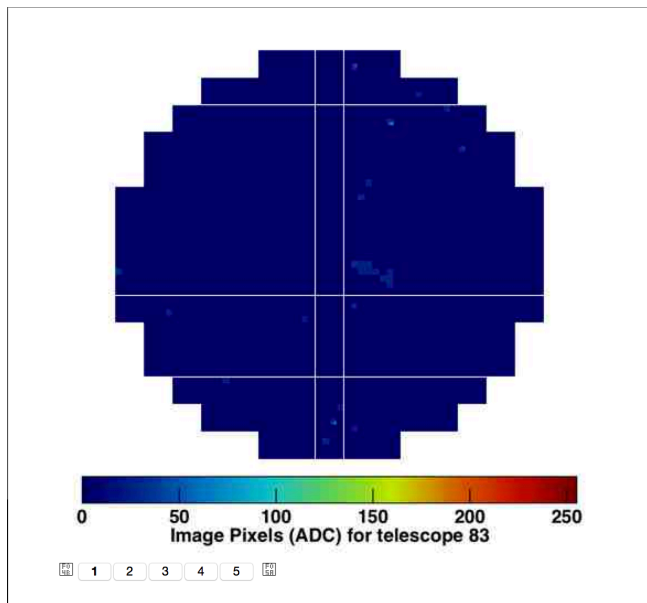


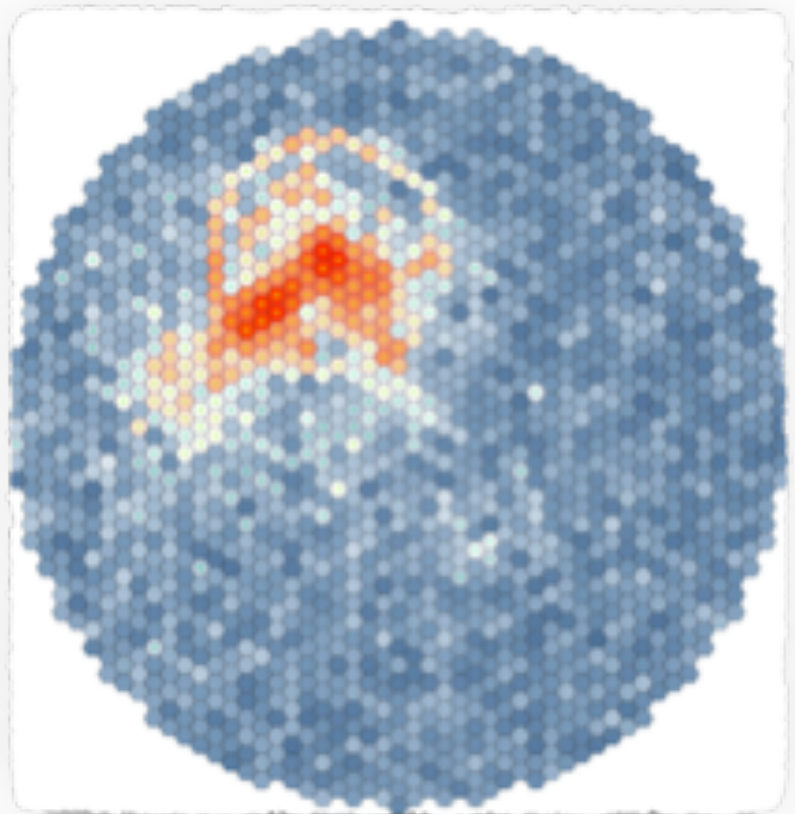
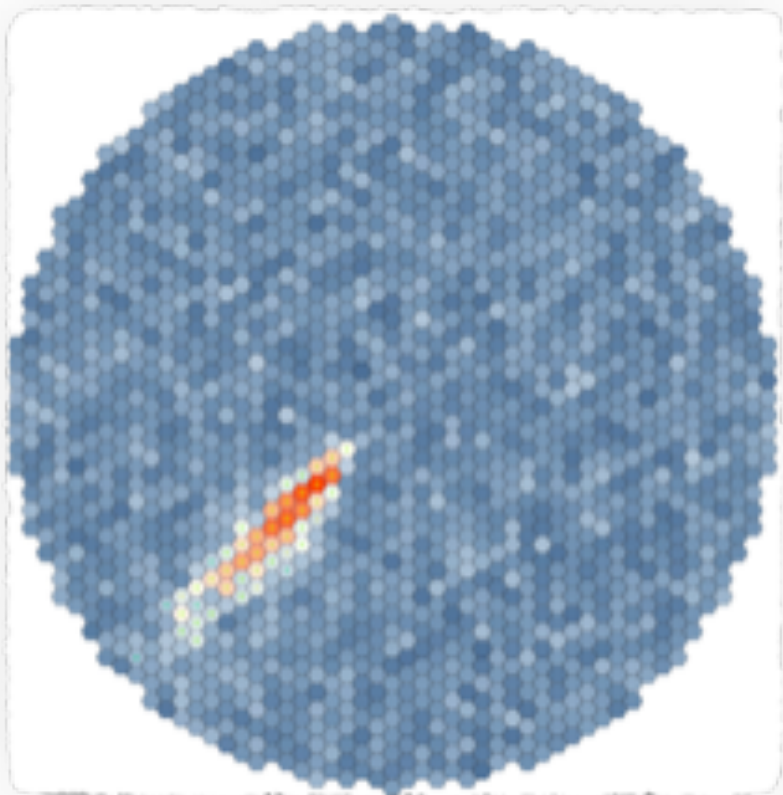
# A call from Cosmos















# SCIENCE COMICS AND CARTOONS

[www.scienceinschool.org](http://www.scienceinschool.org)

THERE IS AN INCREASING AMOUNT OF EVIDENCE THAT COMICS AND STILL CARTOONS CAN BE USEFUL WHEN TEACHING SCIENCE.

CHILDREN ENJOY READING COMICS, AND BOTH THE VISUAL APPEAL OF THE ARTWORK AND THE INTRIGUING NARRATIVE (WHICH CAN BE HUMOROUS AND EDUCATIONAL) MAKE COMICS AN EXCELLENT MEDIUM FOR CONVEYING SCIENTIFIC CONCEPTS IN AN INTRIGUING WAY

THEY CAN BE USED BY TEACHERS AS A LESSON STARTER, TO DETERMINE STUDENT'S PRIOR KNOWLEDGE (SUCH AS EXISTING SCIENTIFIC VOCABULARY, PRECONCEPTIONS AND MISCONCEPTIONS), TO MOTIVATE STUDENTS TO ASK QUESTIONS, AND TO HELP STUDENTS' UNDERSTANDING OF SCIENCE TOPICS BY ALLOWING THEM TO PRODUCE THEIR OWN COMICS

# HISTORY

THE FIRST CONCEPT CARTOONS WERE CREATED BY  
BRENDA KEOGH AND STUART NAYLOR IN 1991

THE RESPONSE OF LEARNERS TO THESE CONCEPT  
CARTOONS WAS ENCOURAGING.

PRIMARY SCHOOL STUDENTS AND TEACHERS ALL  
RESPONDED VERY POSITIVELY

# CHARACTERISTICS

CONCEPT CARTOONS ARE BASED ON EVERYDAY SITUATION THAT DON'T APPEAR TO BE SCIENTIFIC, SO STUDENTS LACKING IN CONFIDENCE ARE LESS LIKELY TO BE INTIMIDATED BY THE SCIENCE AND MORE LIKELY TO ENGAGE WITH THEM

THESE EVERYDAY SITUATIONS APPEAR TO BE EFFECTIVE ACROSS GEOGRAPHICAL AND CULTURAL BOUNDARIES, ENABLING CONCEPT CARTOONS TO BE USED SUCCESSFULLY IN A WIDE RANGE OF COUNTRIES

THEY PRESENT ALTERNATIVE VIEWPOINTS ON THE SITUATION, INCLUDING THE SCIENTIFICALLY ACCEPTABLE VIEWPOINT(S).

SOMETIME THEY HAVE A BLANK SPEECH BUBBLE, TO GIVE A CLEAR STATEMENT THAT THEY MAY HAVE MORE IDEAS THAT ARE NOT INCLUDED IN THE DIALOGUE SO THAT LEARNERS ARE ENCOURAGED TO EXPLORE ALTERNATIVE IDEAS

THE BACKGROUND TEXT IS WRITTEN IN STUDENTS' LANGUAGE, SO THEY CAN BE USED INDEPENDENTLY BY LEARNERS IF THE TEACHER FEELS THAT THIS IS APPROPRIATE



IN MY OPINION, THE BEST REASON TO USE CONCEPT CARTOONS IS THAT THEY PERMIT TO OBJECTIFY THE SITUATION AND THE CHARACTERS LIVING IN IT.

THIS WAY, STUDENTS LIVE INDIRECTLY THE SCIENTIFIC PROBLEM AND CAN FREELY MAKE THE CHOICE OF ENTERING IN EMPATHY WITH THE CHARACTER OR THE OPPOSITE CHOICE: THEY CAN PREFER TO LOOK AT WHAT HAPPENS TO THE GUY LIVING IN THE CARTOON AVOIDING TO FEEL EMBARRASSED, ANGRIED, AFRAID OF SAYING THE WRONG THING,...

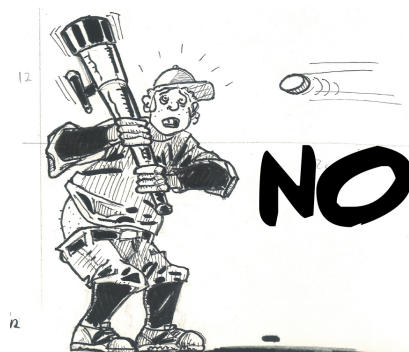
SOME WAY, HE LIVES PART OF THE EXPERIENCE OF HIS TEACHER WHEN HE LISTENS TO HIS PUPILS EXPRESSING IDEAS: HE STAYS ON STEP BACK AND HAS THE POSSIBILITY TO BETTER THINK TO THE PHYSICAL PROBLEM. THIS HELP THE STUDENT TO LIVE FOR A WHILE IN A DIFFERENT POSITION, AND WITH A DIFFERENT POINT OF VIEW.



NO!...



NO!!...



NO!!!

# SPAZIO AI GIOVANI!



HEY TU DICO A TE!



SI, DICO PROPRIO A TE!  
SAI NIENTE DI ASTRONOMIA?  
SE INTENDI CAPIRE DI COSA SI TRATTA,  
DOVRAI PRIMA SCOPRIRE CHE STRUMENTO  
USANO GLI ASTRONOMI.  
SÌ, PERCHÉ SE PER MANGIARE USI LE  
POSATE, SE PER TELEFONARE USI IL CELLU-  
LARE, SE PER GIOCARE A TENNIS USI LA  
RACCHETTA, PRESTO VEDRAI CHE PER FARE  
ASTRONOMIA TI SERVIRÀ UN OGGETTO  
MOLTO PARTICOLARE: IL **TELESCOPIO**.

COME **NON** SI USA IL TELESCOPIO



**NO!...**



**NO!!...**

COME **SÌ** SI USA IL TELESCOPIO

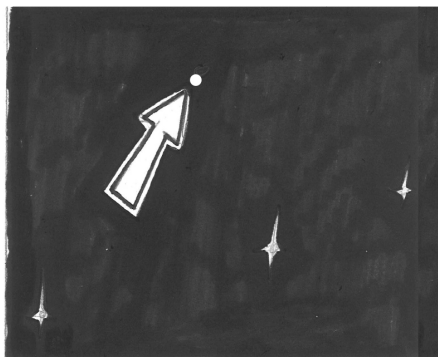


**NO!!!**

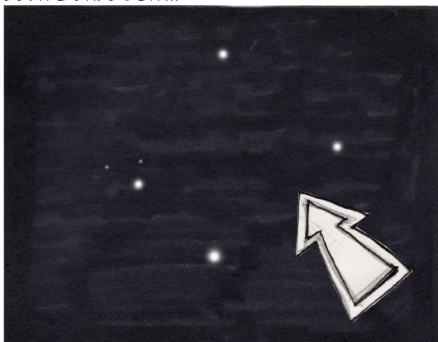
SE INVECE DI USARE IN MODO  
IMPROPRIO QUESTO STRU-  
MENTO, TU PROVASSI A  
POGGIARE L'OCCHIO SUL SUO  
OCULARE PUNTANDO IL TUBO  
VERSO IL CIELO, POTRESTI  
VEDERE COSE CHE NEANCHE  
RIESCI A IMMAGINARE:



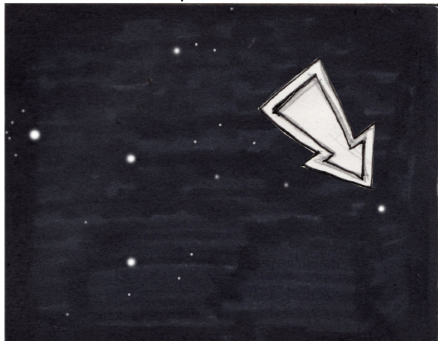
AD OCCHIO NUDO VEDRAI COSÌ...



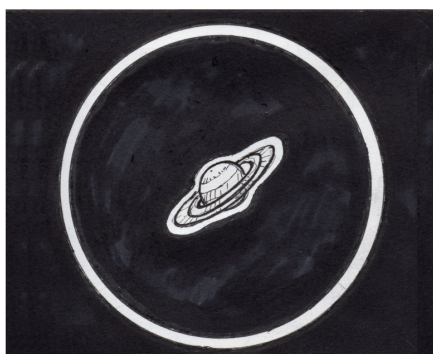
NELLA COSTELLAZIONE DI **ERCOLE**, NON SOSPETTERESTI MAI CHE IN QUEL PUNTO SI CELA QUALCOSA...



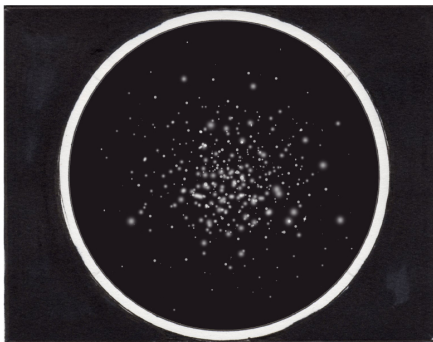
GUARDANDO AD OCCHIO NUDO LA COSTELLAZIONE DEL **CIGNO** NON POTRESTI MASCOPIRIRE CHE **ALBIREO**, LA TESTA DEL VOLATILE...



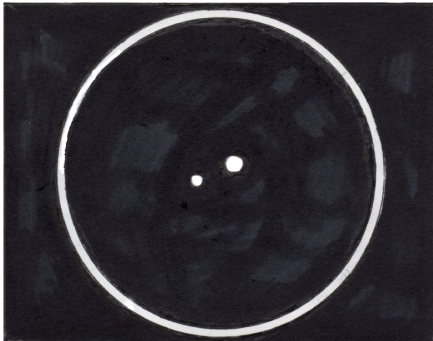
... MENTRE COL TELESCOPIO QUEL PUNTINO RISULTERÀ ESSERE **SATURNO**!



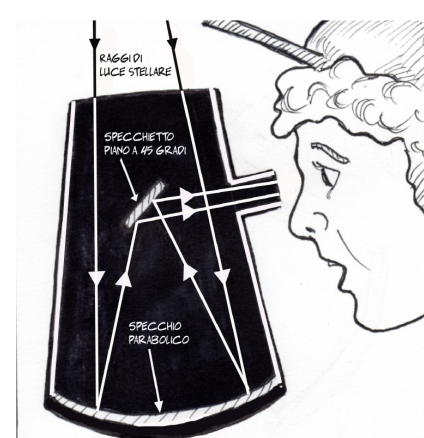
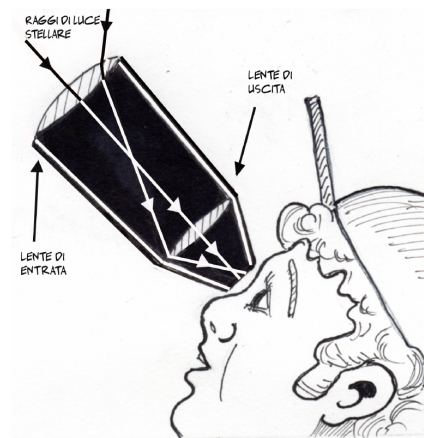
... MA COL TELESCOPIO POTRESTI VEDERE LO SPENDIDO **AMMASSO GLOBULARE M13**!



... E' IN REALTÀ UNA SPENDIDA STELLA DOPPIA!



QUINDI, RICAPITOLANDO, IL TELESCOPIO E' COME UN PAIO DI OCCHIALI MOLTO POTENTI CHE CI CONSENTE DI VEDERE COSE LONTANISSIME E QUINDI INVISIBILI AL NOSTRO OCCHIO NUDO. ESISTONO DUE TIPI DI TELESCOPIO: UNO USA LE LENTI, L'ALTRO GLI SPECCHI



QUALSIASI SIA IL TIPO DI TELESCOPIO CHE USERAI, UNA COSA E' CERTA: TI RIEMPIRAI GLI OCCHI DI CIELO E STELLE!!!



INAF-Osservatorio  
Astronomico  
di Bologna

INAF - OSSERVATORIO ASTRONOMIC DI BOLOGNA  
VIA RANZANI 1, 40127 BOLOGNA- ITALY  
TEL. +39- 051 2095701, FAX +39- 051 2095700  
E-MAIL: DIVULGAZIONE@OABO.INAF.IT

SOGGETTO, TESTO, DISEGNI E PROGETTO GRAFICO:  
ANGELO ADAMO  
COL CONTRIBUTO DELLA FONDAZIONE DEL MONTE



FONDAZIONE DEL  
MONTE

1473



# SPAZIO AI GIOVANI!

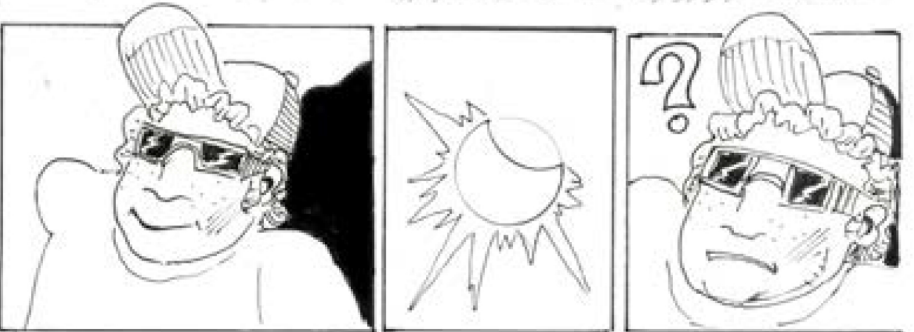
2

ecLissi

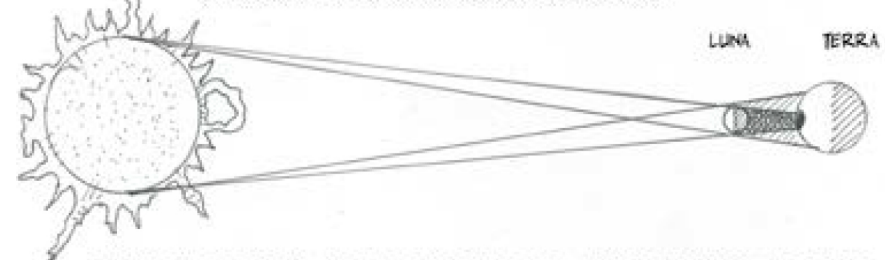




QUALCOSA DI SIMILE  
CAPITA ANCHE IN NATURA...



CERCHIAMO DI CAPIRE COSA E' ACCADUTO: MENTRE STAVATE GODENDO  
DELLO SPETTACOLO DEL MOTO DIURNO DEL SOLE, E' CAPITATO DI VEDER  
PASSARE LA LUNA DAVANTI AL DISCO SOLARE.  
OGNI TANTO CAPITA E SI SCOPRE CHE IL CERCHIO LUMINOSO DEL SOLE HA  
DIMENSIONI MOLTO SIMILI A QUELLO DELLA LUNA.



QUESTO ACCADE PER UN PURO E STRANO CASO: INFATTI IL SOLE HA UN RAGGIO  
DI CIRCA 700.000 CHILOMETRI, MENTRE QUELLO DELLA LUNA MISURA SOLO  
1700 CHILOMETRI.  
SI SOVRAPPONGONO BENE A CAUSA DELLA DIFFERENTE DISTANZA DA NOI: IL SOLE  
DISTA CIRCA 150 MILIONI DI CHILOMETRI, MENTRE LA LUNA DISTA DA NOI  
SOLO 384.000 CHILOMETRI.



A CONTI FATTI, RISULTA CHE IL SOLE HA UN RAGGIO 400 VOLTE PIU' GRANDE DI QUELLO  
DELLA LUNA E DISTA DA NOI 400 VOLTE DI PIU' DEL NOSTRO SATELLITE NATURALE.

OVVIAMENTE, COME SI VEDE DAL DISEGNO QUI SOPRA, OLTRE ALLE ECULSI DI SOLE CHE  
ABBIAMO VISTO NELLE PAGINE PRECEDENTI, (SPIEGATE NEL DISEGNO IN ALTO IN QUESTA  
PAGINA), E' POSSIBILE CHE SI VERIFICHINO ANCHE ECULSI DI LUNA: QUANDO ESSA PASSA  
PROPRIO DIETRO AL NOSTRO PIANETA, I RAGGI SOLARI NON RIESCONO A RAGGIUNGERLA  
ED ESSA SPARISCE NELL'OMBRA PROIETTATA DALLA TERRA PER POI RICOMPARIRE DOPO  
UN TEMPO LUNGO AL MASSIMO UN'ORA E MEZZA.

SOGGETTO, TESTO E DISEGNI:  
ANGELO ADAMO INAF OSSERVATORIO ASTRONOMICICO DI BOLOGNA  
VIA RANZANI, 1, 40127 BOLOGNA, ITALIA



# SPAZIO AI GIOVANI! 3

DA EXTRATERRESTRE A EXTRASOLARE  
IL TRANSITO DI MERCURIO E LA SCOPERTA DI PIANETI ALIENI



**CIAO A TUTTI!**

**PRIMA DI INIZIARE,  
VORREI PORVI UNA  
DOMANDA:**

**SAPETE COSA SONO I  
PIANETI EXTRASOLARI?**

**NO? ALLORA VE LO DICO IO:  
SONO PIANETI CHE INVECE DI  
ORBITARE ATTORNO AL SOLE...**

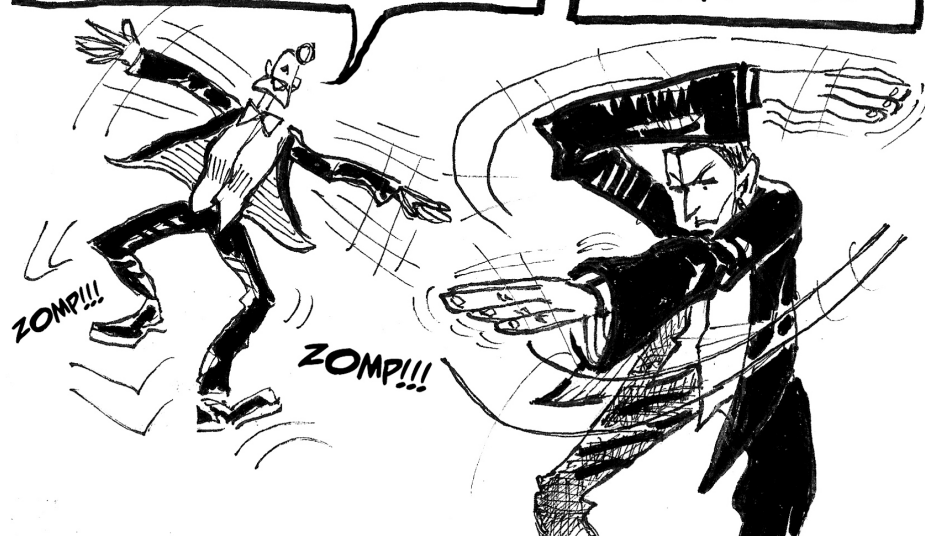
**... GIRANO ATTORNO AD  
ALTRE STELLE MOLTO,  
MOLTO LONTANE DA QUI!**



**QUEST'ANNO CI  
VIENE OFFERTA  
UNA GRANDE OP-  
PORTUNITA' CHE  
SAREBBE UN VERO  
DELITTO NON  
SFRUTTARE:  
LUNEDI'  
PROSSIMO,  
9 MAGGIO 2016**  
...

**POTREMO ALLENARCI A OSSER-  
VARE PIANETI ALIENI USANDO...**

**... IL METODO DEI  
TRANSITI!**

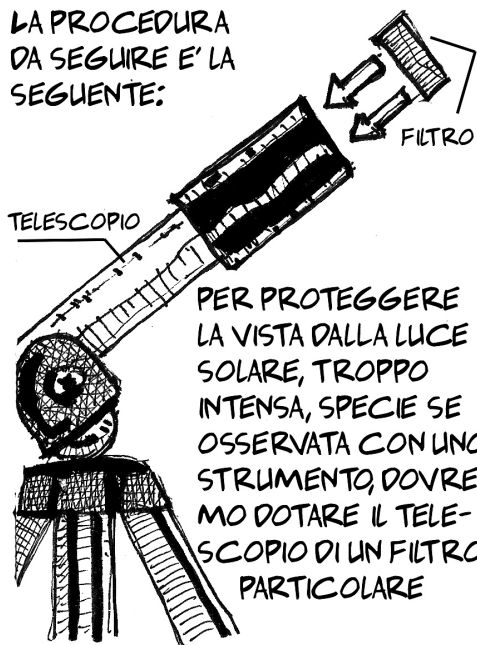




PER CAPIRE IN COSA CONSISTA  
E COME SI APPLICA, LA NOSTRA  
PALESTRA SARA' IL SISTEMA  
SOLARE E COME ATTREZZO  
USEREMO...

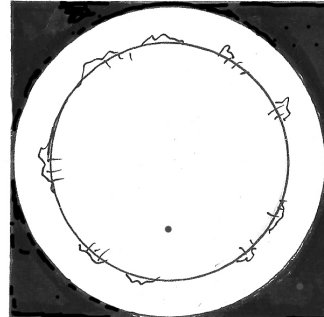
... UN PIANETA CHE NON E' LA NOSTRA  
TERRA, MA UNO DEGLI ALTRI SETTE  
PIANETI VICINI.  
UN PIANETA... EXTRATERRESTRE!

LA PROCEDURA  
DA SEGUIRE E' LA  
SEGUENTE:



PER PROTEGGERE  
LA VISTA DALLA LUCE  
SOLARE, TROPPO  
INTENSA, SPECIE SE  
OSSERVATA CON UNO  
STRUMENTO, DOVRE-  
MO DOTARE IL TELE-  
SCOPIO DI UN FILTRO  
PARTICOLARE

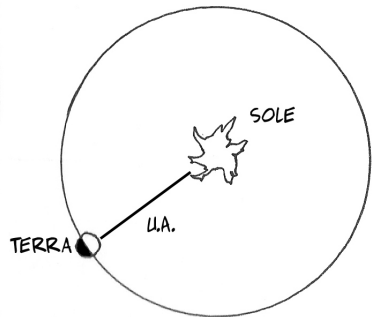
COSI' EVITEREMO CHE  
IL SOLE CI ACCECHI  
METTENDO... A FUOCO  
IL NOSTRO OCCHIO!



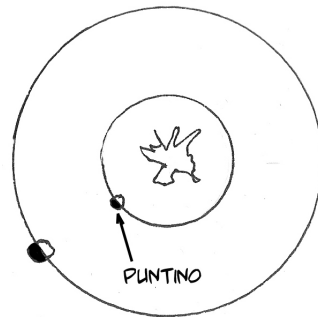
ALL' ORA GIUSTA, PUNTANDO IL TELE-  
SCOPIO VERSO IL SOLE, VEDREMO UN  
PUNTINO NERO CHE ATTRAVERSERA'  
LENTAMENTE IL DISCO SOLARE,  
ANDANDO DA UN SUO LATO ALL' ALTRO.  
LO VEDREMO PER CONTRASTO:  
NONOSTANTE SIA MOLTO PICCOLO,...



... RIESCE SEMPRE  
A BLOCCARE SULLA  
FACCIA CHE  
GUARDA LA TORCIA  
SOLARE UN PO'  
DELLA LUCE CHE  
LO INONDA.  
COSI' FACENDO,  
QUEL GIORNO CI  
MOSTRERA' LA SUA  
"NUCA", IL SUO LATO IN  
OMBRA



E' NOTO CHE NOI GIRIAMO ATTORNO AL SOLE STANDO SU UN' ORBITA QUASI CIRCOLARE CON UN RAGGIO CHE CHIAMIAMO UNITA' ASTRONOMICA (U.A.).

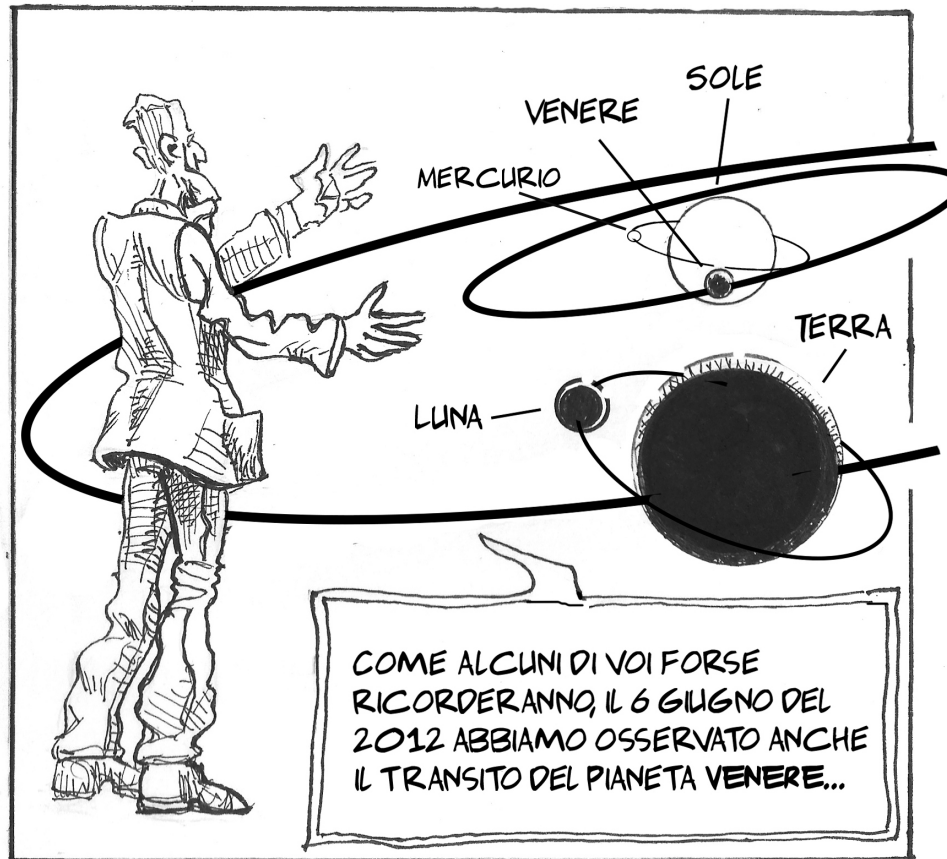
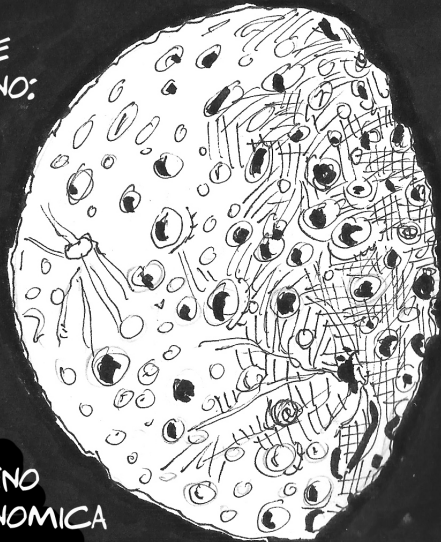


QUEL PUNTINO NERO CHE VEDREMO IN MOVIMENTO CI DIRA' ALLORA CHE LI', TRA NOI E IL SOLE, C' E' QUALCOSA CHE SI MUOVE SU UNA CIRCONFERENZA PIU' PICCOLA DI QUELLA TERRESTRE

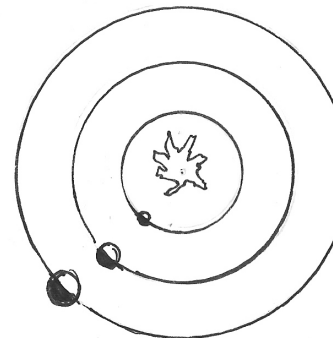
E NOI SAPPIAMO BENE COS' E' QUEL PUNTINO:

**E' IL PIANETA MERCURIO!**

UN PIANETA PIU' PICCOLO DELLA TERRA CHE DISTA DAL SOLE MOLTO MENO DI UNA UNITA' ASTRONOMICA



COME ALCUNI DI VOI FORSE RICORDERANNO, IL 6 GIUGNO DEL 2012 ABBIAMO OSSERVATO ANCHE IL TRANSITO DEL PIANETA VENERE...



... CHE, ORBITANDO ATTORNO AL SOLE SU UN' ORBITA PIU' PICCOLA DI QUELLA DELLA TERRA, MA PIU' GRANDE DI QUELLA DI MERCURIO, E' IL SECONDO PIANETA DEL SISTEMA SOLARE (NOTA BENE: LA TERRA E' IL TERZO)

E CON LO STESSO METODO, ...



MA CON TELESCOPI  
MOLTO PIU' GRANDI,  
QUINDI MOLTO PIU'  
POTENTI DI QUELLI CHE  
BASTANO PER I VICINI  
VENERE E MERCURIO

MAMMA!

... RIUSCIAMO A COGLIERE  
ANCHE IL TRANSITO DI LONTA-  
NISSIMI PIANETI EXTRASOLARI  
SOPRENDENDOLI PROPRIO  
MENTRE PASSANO DAVANTI AL  
DISCO DELLA STELLA ATTORNO.  
ALLA QUALE STANNO  
ORBITANDO

ED ORA, PER GIOCARE  
UN PO' CON QUESTI  
CONCETTI COSI' AFFA-  
SCINANTI, VI PROONGO  
UN FACILE QUESITO:

DI QUALE DEGLI ALTRI PIANETI E SATELLITI DEL SISTEMA  
SOLARE POTREMO PRIMA O POI OSSERVARE UN TRANSITO  
SUL DISCO SOLARE?

MARTE ☐ GIOVE ☐ SATURNO ☐ URANO ☐  
NETTUNO ☐ PLUTONE ☐ LUNA ☐



TESTO, SCENEGGIATURA E DISEGNI: ANGELO ADAMO  
INAF-OSSERVATORIO ASTRONOMICCO DI BOLOGNA  
ANGELO.ADAMO@OABO.INAF.IT





# EAGLE VIEW NETWORK

HOW COOPERATION ACHIEVED THE SHARPEST VIEW OF THE UNIVERSE

WHY DIDN'T YOU KEEP YOUR HANDS OFF?

I WAS DOING IT! YOU ALMOST DELETED EVERYTHING! KEEP OUT OF MY WAY!



DO YOU THINK FIGHTING WILL SOLVE THINGS? CAN'T YOU TWO WORK TOGETHER?

SEE, WORKING TOGETHER IS ALWAYS THE BEST WAY OF DOING THINGS, AND SOMETIMES THE ONLY WAY.

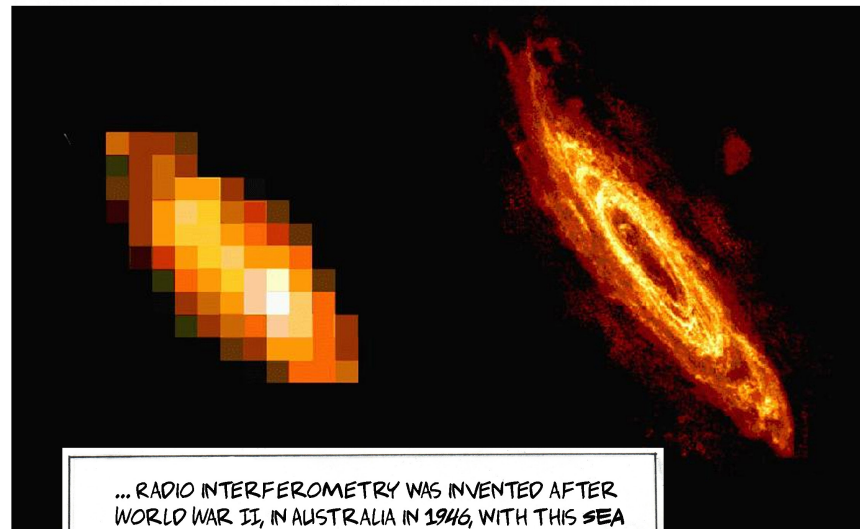
"THINK ABOUT RADIO ASTRONOMY. RADIO WAVES ARE SO LONG THAT..."



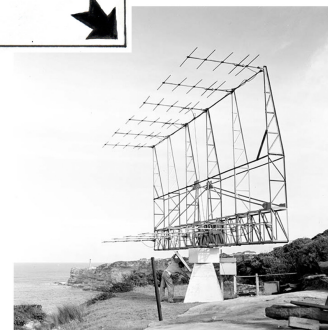
... THE ONLY WAY OF OBSERVING THINGS IN DETAIL IS TO BUILD TELESCOPES HUNDREDS OF METRES IN DIAMETER. IMPOSSIBLE!"



THEREFORE, VERY DETAILED OBSERVATIONS NEED SEVERAL WIDE-SPREAD ANTENNAS, WORKING AS ONE, OBSERVING THE SAME OBJECT IN THE SKY. THIS SYSTEM IS A RADIO INTERFEROMETER AND HAS THE SAME ABILITY TO DISCERN DETAILS AS A TELESCOPE AS BIG AS THE MAXIMUM DISTANCE BETWEEN THE ANTENNAS



... RADIO INTERFEROMETRY WAS INVENTED AFTER WORLD WAR II, IN AUSTRALIA IN 1946, WITH THIS **SEA CLIFF INTERFEROMETER**, WHICH SIMULATED A 100-M RADIO TELESCOPE





IN THE LATE '50S THE FIRST RADIO LINKED INTERFEROMETER WAS BUILT IN THE UK. THIS ALLOWED GREATER DISTANCES BETWEEN ANTENNAS THAN COULD BE ACHIEVED WITH CABLE CONNECTIONS.

OK, MUM WE'RE DONE FIGHTING. COULD YOU PLEASE STOP TALKING ABOUT YOUR JOB FOR ONCE?

YOU'VE ALREADY TOLD US EVERYTHING: THINGS THAT LOOKED AS ONE BUT WERE TWO INSTEAD, STAR-LIKE THINGS THAT TURNED OUT TO BE GIANT GALAXIES WITH BLACK HOLES INSIDE...

... ARE YOU SURE? YOU DON'T KNOW THAT THIS EXPERIMENT INVOLVED TRANSPORTING PORTABLE ANTENNAS ON TRUCKS AND PERSUADING FARMERS TO LET THEM USE A CORNER OF THEIR FIELD. LOTS OF RUBBER BOOTS AND MUD INVOLVED...



scienza  
express

AND, I NEVER TOLD YOU HOW THIS SCIENTIFIC COOPERATION CROSSED NATIONAL BOUNDARIES, REGARDLESS OF POLITICAL AND DIPLOMATIC TENSIONS, JUST SEEKING TO KNOW MORE ABOUT OUR UNIVERSE FOR EXAMPLE, IN 1964, THERE WAS NO PROBLEM IN STARTING A COLLABORATION BETWEEN MANCHESTER AND MOSCOW."

WASN'T THAT DURING THE COLD WAR?

YES! CAN YOU BELIEVE IT? IN THE 1960S INTERFEROMETRIC EQUIPMENT WAS DELIVERED FROM THE US TO RUSSIA. THERE SEEMS TO HAVE BEEN NO PROBLEMS GETTING THINGS FROM THE US TO RUSSIA EVEN DURING THOSE DIFFICULT TIMES, AS LONG AS IT WAS FOR RADIO ASTRONOMY!

WAS RADIO ASTRONOMY THAT IMPORTANT?

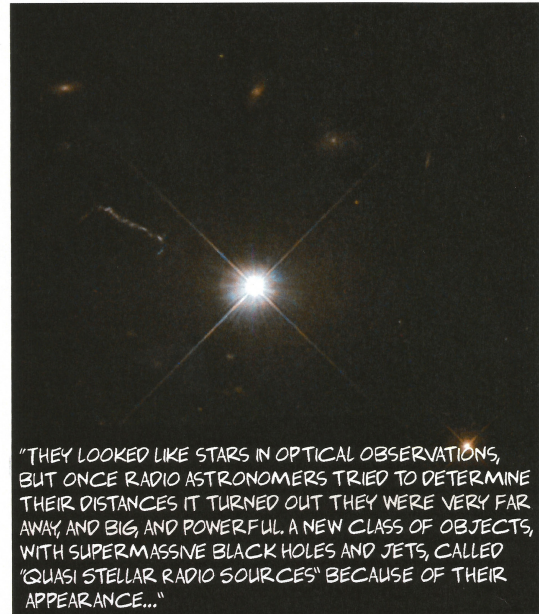
ALL SCIENTISTS USUALLY WORK OUTSIDE POLITICAL BOUNDARIES, IF THEY CAN: IN THIS CASE, RADIO ASTRONOMY WOULD HAVE BEEN INCOMPLETE WITHOUT INTERFEROMETRIC OBSERVATIONS

scienza  
express

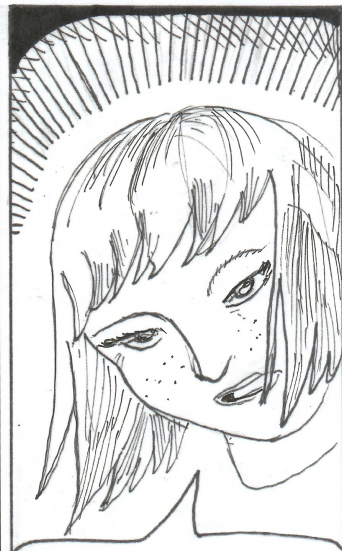




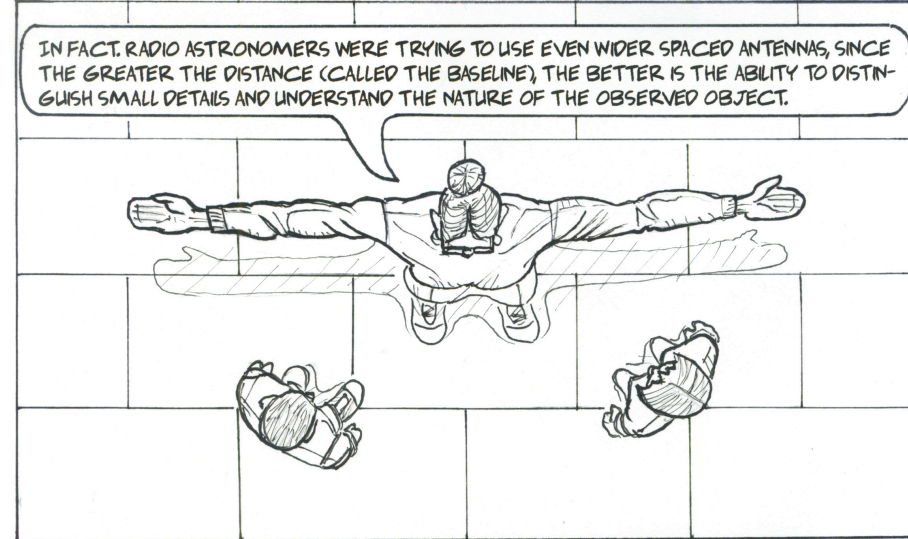
NOT AT ALL! IT'S NOT ONLY ME; EVERYONE BACK THEN WAS CONVINCED THAT INTERFEROMETRY WAS THE FUTURE OF RADIO ASTRONOMY: YOU ALREADY KNOW THE STORY OF THE DISCOVERY OF QUASARS IN 1963...



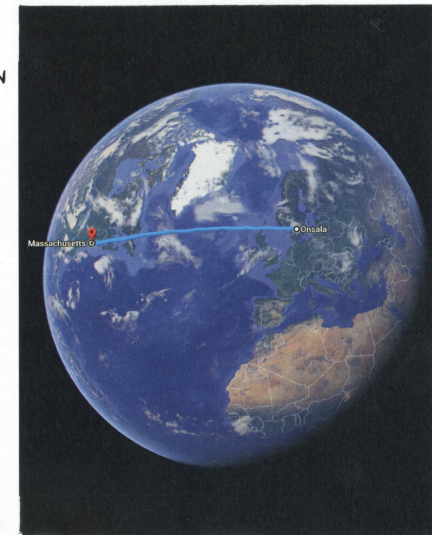
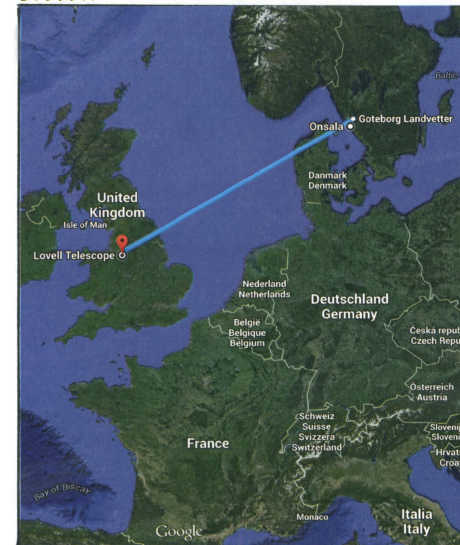
"THEY LOOKED LIKE STARS IN OPTICAL OBSERVATIONS, BUT ONCE RADIO ASTRONOMERS TRIED TO DETERMINE THEIR DISTANCES IT TURNED OUT THEY WERE VERY FAR AWAY, AND BIG AND POWERFUL. A NEW CLASS OF OBJECTS, WITH SUPERMASSIVE BLACK HOLES AND JETS, CALLED 'QUASI STELLAR RADIO SOURCES' BECAUSE OF THEIR APPEARANCE..."



... WE KNOW THIS. WHAT I DIDN'T KNOW IS THAT THEY WERE DISCOVERED USING INTERFEROMETRY.



IN 1967 THE FIRST VERY LONG BASELINE INTERFEROMETRY (VLBI) OBSERVATION BETWEEN TWO EUROPEAN RADIO TELESCOPES WAS RUN: THEY WERE THE LOVELL TELESCOPE (BACK THEN MKI) IN THE UK AND THE ONSALA TELESCOPE, IN SWEDEN."



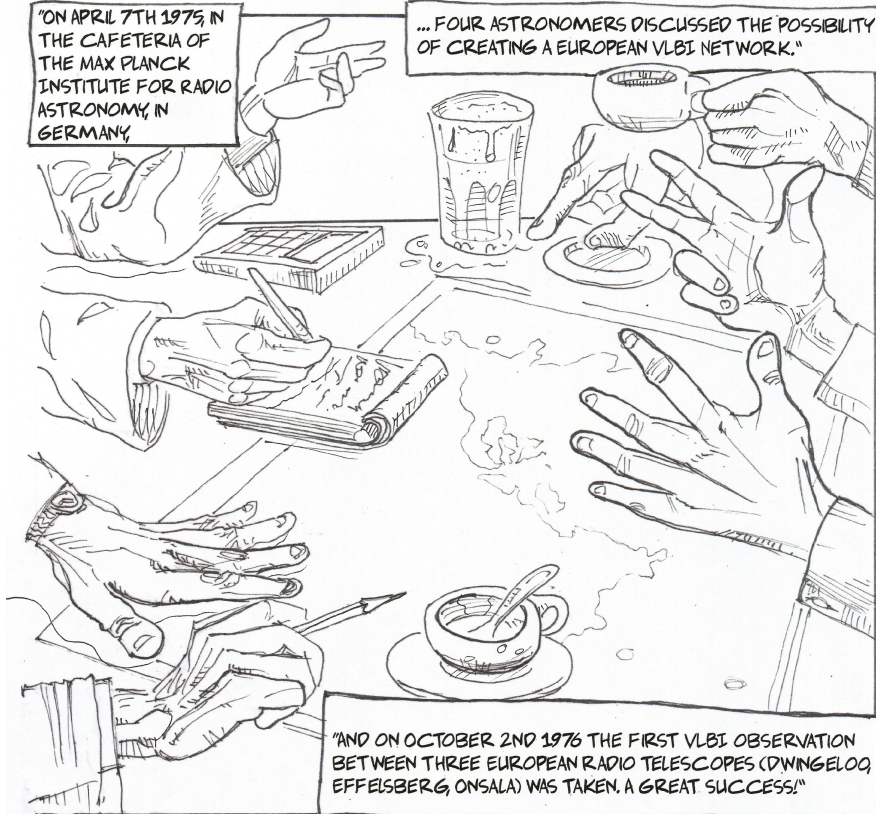
"THE YEAR AFTER, THERE WAS THE FIRST TRANSATLANTIC VLBI OBSERVATION WITH THREE ANTENNAS THIS TIME, LOCATED IN WEST VIRGINIA, MASSACHUSETTS AND SWEDEN."



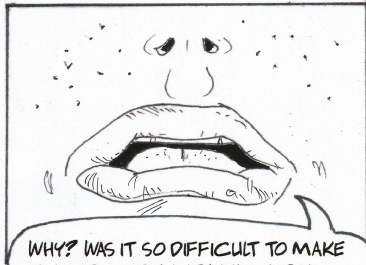


"ON APRIL 7TH 1975, IN THE CAFETERIA OF THE MAX PLANCK INSTITUTE FOR RADIO ASTRONOMY, IN GERMANY,

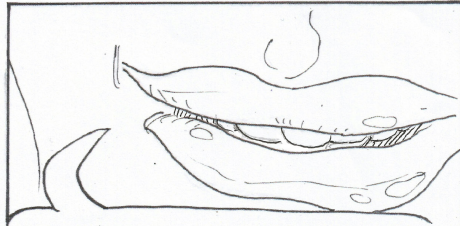
"... FOUR ASTRONOMERS DISCUSSED THE POSSIBILITY OF CREATING A EUROPEAN VLBI NETWORK."



"AND ON OCTOBER 2ND 1976 THE FIRST VLBI OBSERVATION BETWEEN THREE EUROPEAN RADIO TELESCOPES (Dwingelo, Effelsberg, Onsala) WAS TAKEN. A GREAT SUCCESS!"



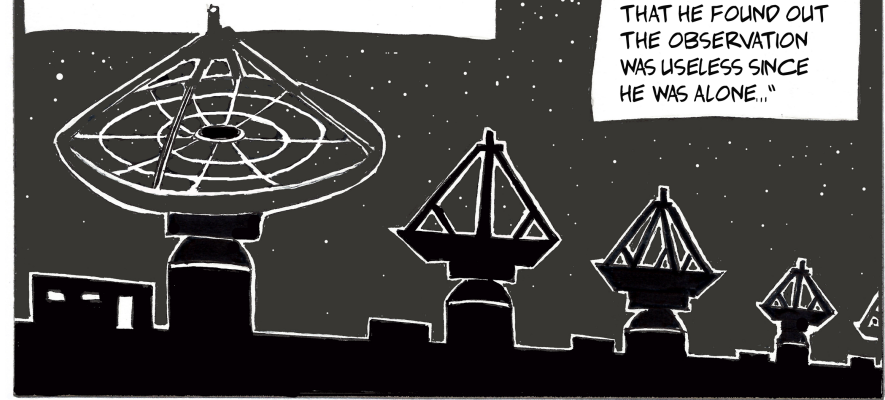
WHY? WAS IT SO DIFFICULT TO MAKE TWO OR MORE ANTENNAS WORK TOGETHER? DIDN'T THEY JUST HAVE TO AGREE ABOUT OBSERVING THE SAME OBJECT AT THE SAME TIME?



I WISH IT WAS THAT SIMPLE: EVERYBODY HAD TO DO EXACTLY THE SAME THINGS EVERYWHERE (POINTING THE ANTENNA, CHANGING THE TAPES..)

scienza  
express

"AND ALL TELESCOPES HAD TO WORK PROPERLY FOR THE ENTIRE VLBI OBSERVING TIME.. ONCE, DURING A VLBI OBSERVATION, ALL TELESCOPES HAD PROBLEMS, EXCEPT ONE..."

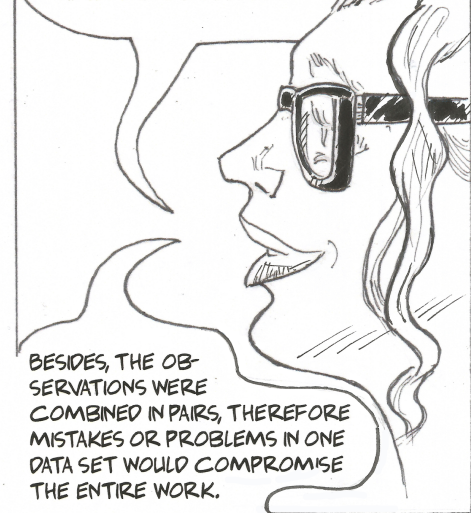


"... THE OPERATOR AT THAT TELESCOPE OBSERVED ALL WEEKEND: IT WAS ONLY IN THE END THAT HE FOUND OUT THE OBSERVATION WAS USELESS SINCE HE WAS ALONE..."

NOOOO, TOO BAD! WHY WAS THE OBSERVATION USELESS?"



BECAUSE, IN ORDER TO MAKE AN INTERFEROMETRIC OBSERVATION, AT LEAST TWO OPERATING ANTENNAS ARE NEEDED..



BESIDES, THE OBSERVATIONS WERE COMBINED IN PAIRS, THEREFORE MISTAKES OR PROBLEMS IN ONE DATA SET WOULD COMPROMISE THE ENTIRE WORK.

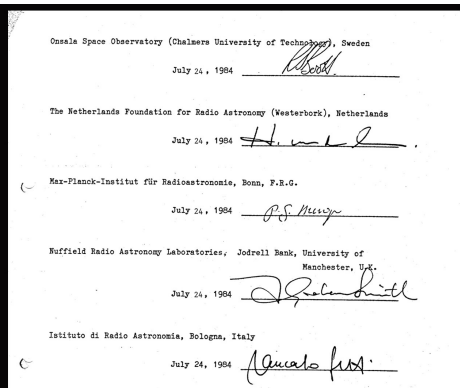
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"AT THE BEGINNING, DATA WERE SENT TO THE US TO BE COMBINED (CORRELATED)"



"IN 1978, THE FIRST EUROPEAN CORRELATOR DEDICATED TO VLBI DATA WAS CREATED IN BONN"

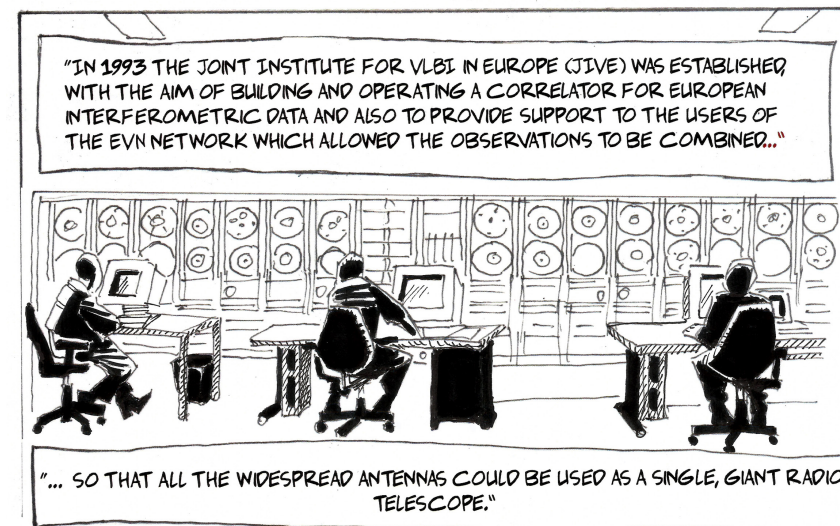
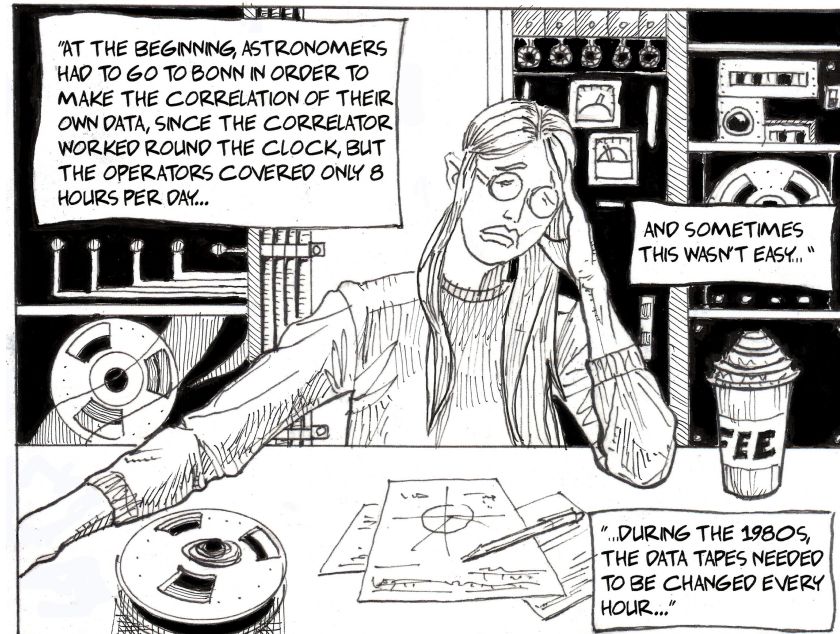


"ON MARCH 5TH 1980, THE EUROPEAN VLBI NETWORK (EVN) WAS BORN AND IN 1984 A EUROPEAN CONSORTIUM WAS FORMED, INCLUDING BOLOGNA, BONN, JODRELL BANK, ONSALA AND WESTERBORK"



"I USED DATA FROM THIS NETWORK FOR MY THESIS WORK, WHICH I HAVE ALREADY TOLD YOU ABOUT.. SO MANY NIGHTS SPENT FOR DATA CORRELATION.."

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express



scienza  
express



AFTER THE OBSERVATION, THE TAPES WERE SENT TO JIVE. THERE WERE VERY STRICT RULES FOR THE TIMING OF THESE DELIVERIES, ALTHOUGH OFTEN THEY WERE LATE, AND SOMETIMES THERE WERE PROBLEMS WITH THE CUSTOMS

THAT'S FAIR!  
IF I WERE A  
CUSTOMS OFFICER,  
I WOULD WORRY AS  
WELL.... BIG DATA  
TAPES...

... IN A TIME OF SPIES  
AND INTERNATIONAL  
INTELLIGENCE AGENCIES  
...

"YOU BOTH WOULD BE SURPRISED  
TO KNOW THAT AT THAT VERY  
SAME TIME, AN ATOMIC CLOCK  
WAS FLOWN TO A NEW OBSERVING  
SITE IN ORDER TO CONNECT THE  
TELESCOPE TO THE NETWORK.  
IT WAS GIVEN A TICKET IN THE  
NAME OF MR. A. CLOCK!"

Air ticket		Air ticket	
Flight		NAME	MR. CLOCK
Date		Flight	
Company		Date	Time
Flight		GATE	
Date	Time	SEAT	
GATE			
SEAT			

"I'VE BORED YOU TWO  
ENOUGH; THAT'S THE  
END OF THE STORY"



IN 2006 ELECTRONIC VLBI BECAME  
AVAILABLE ON THE NETWORK.  
THE DATA TRANSFER FINALLY BECAME  
QUICK: NOW ELEVEN ANTENNAS ARE  
CONNECTED VIA OPTICAL FIBER

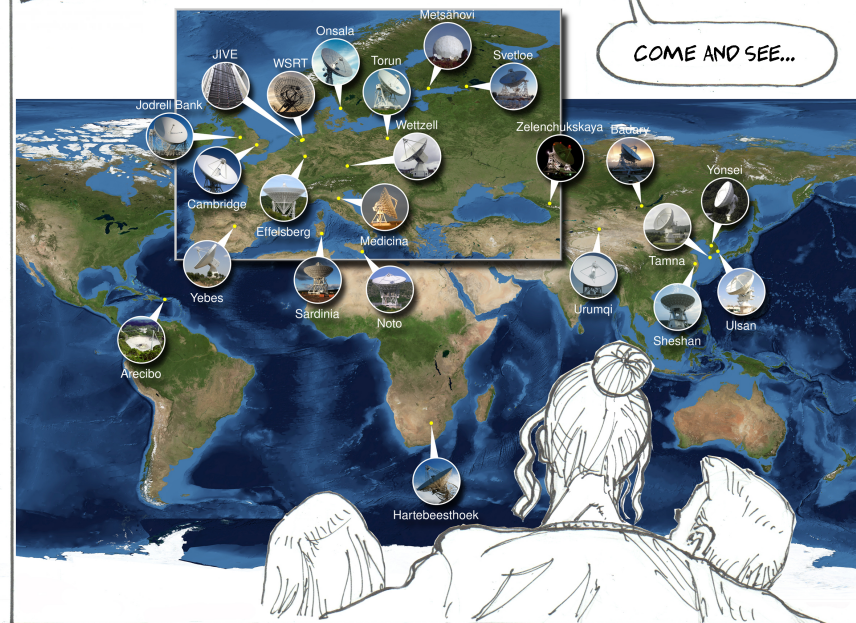
ELEVEN?  
HOW MANY ARE  
THERE ALTOGETHER?

CONCEPT WORKING GROUP OF RADIONET3 TASK 3  
"OUTREACH FOR THE GENERAL PUBLIC"  
TEXT: STEFANIA VARANO  
SCREENPLAY: STEFANIA VARANO, ANGELO ADAMO  
DRAWINGS: ANGELO ADAMO  
(C) SCIENZA EXPRESS EDIZIONI, 2015  
LICENCE: CREATIVE COMMONS BY-NC-SA

THIS DOCUMENT HAS BEEN PRODUCED WITHIN THE SCOPE OF  
THE RADIONET3 PROJECTS. THE UTILIZATION AND RELEASE OF THIS  
DOCUMENT IS SUBJECT TO THE CONDITIONS OF THE CONTRACT  
WITHIN THE EUROPEAN COMMISSION SEVENTH FRAMEWORK  
PROGRAMME (FP7/2007-2013), GRANT AGREEMENT NO  
2-83393 (RADIONET3)



COME AND SEE...



SINCE 1996 SOME BIG PROJECTS INVOLVING THE NETWORKING OF RADIO ASTRONOMY (AND  
THE EUROPEAN VLBI NETWORK) HAVE OBTAINED SIGNIFICANT FUNDING AND ARE COORDINATED  
BY EUROPEAN INFRASTRUCTURE. THIS IS THE CASE OF RADIONET3, COMPRISING 27 PARTNERS.



THE END



CHANGE OF PERSPECTIVE:

NATURE SPEAKS ABOUT HERSELF

# B A O

## Baryon-Acoustic-Oscillations

TEXT, SCREEN PLAY AND DRAWINGS: ANGELO ADAMO, INAF-OABO (IT)  
SCIENTIFIC SUPERVISION: SANDRO BARDELLI, INAF-OABO (IT)



"LET ME INTRODUCE MYSELF:

I AM A BIG HEAP OF PRIMORDIAL DARK MATTER.  
"DARK" BECAUSE I HAVE NOTHING TO DO WITH  
LIGHT, THEREFORE I AM NOT PRECISELY "BLACK".  
"DARK" ALSO BECAUSE...



... YOU HAVE NO IDEA WHAT I AM.  
NO, I HAVE NO INTENTION OF REVEALING  
IT TO YOU.  
I DO NOT WANT TO TELL YOU MY BUSINESS.  
I WILL LIMIT MYSELF TO REPEATING WHAT  
YOU HAVE ALREADY GRASPED WITHOUT  
MY HELP



JUST AFTER THE "IN-FAMOUS"  
BIG BANG, THERE WAS ONLY AN  
EXTREMELY HOT "SLOP"  
FORMED BY SOMETHING WHICH  
YOU POLITELY DUBBED "PLASMA"  
FORMED BY PHOTONS AND  
ELECTRONS. FURTHERMORE,  
THERE WAS ALSO ME AND ALL MY  
NUMEROUS COLLEAGUES, OTHER  
DARK MATTER HEAPS...

... DISTRIBUTED  
OVERALL TO  
SEASON THAT  
SOUP

Angelo Adamo  
1981-2016

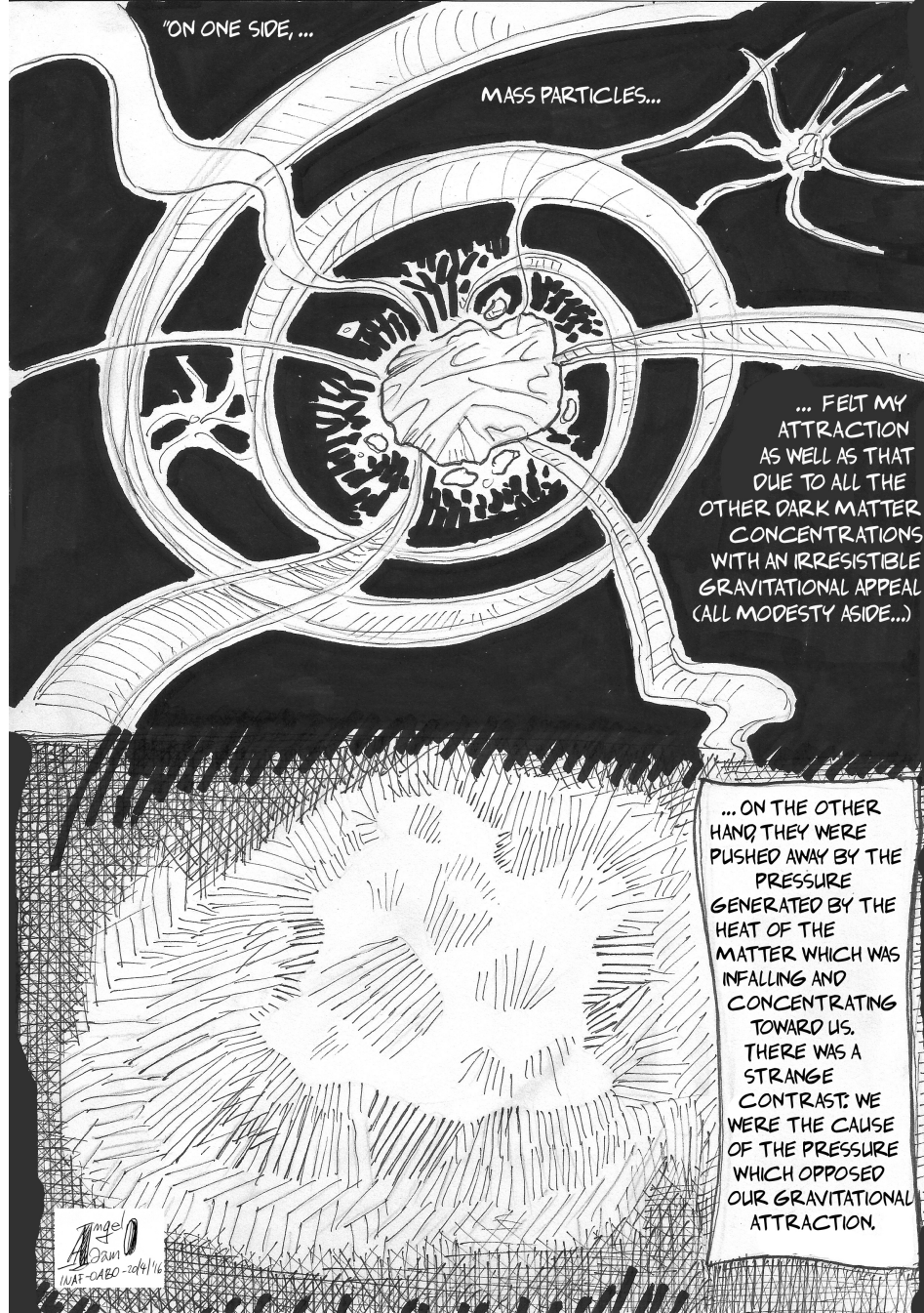


IN A TWO-FOLD UNIVERSE,  
GEOMETRY IS TIME

LOOK-BACK TIME:

- PAST IS LITTLE, IN FRONT OF YOU;
- "NOW" IS THE PLACE YOU ARE IN;
- FUTURE IS YOUR BACK







"FROM THIS CONTRAST  
BETWEEN ATTRACTION AND  
REPULSION..."

... FROM THIS INTERNAL TENSION  
AROUND THE UNIVERSE,...

... AROSE A GENERAL OSCILLATION OF THE  
PLASMA, SIMILAR TO THAT PRODUCED BY A  
STONE LAUNCHED IN A LAKE OR...

... SIMILAR TO A COSMIC SOUND, ALTHOUGH  
(BELIEVE ME) FOR US BYSTANDERS IT WAS  
NOT A MELODIOUS SONG BUT...

... A PAINFUL **SCREAM** OF  
RELUCTANCE."

THE GOAL HERE IS TO CREATE A  
SYMPATHETIC RELATIONSHIP  
BETWEEN WHO READS AND THE  
UNIVERSE SEEN AS A HUGE, LIVING,  
SUFFERING ENTITY



"AND...

WHEN THE  
UNIVERSE ...

... EXP  
ENOU

... THE LIG

... FINAL  
TO FLO

ME

... THE DARK

"FOOTPRINTS OF THIS TUG-OF-WAR  
BETWEEN BARYONIC AND DARK MATTE  
NOW VISIBLE AS SCARS IN THE SKIN OF  
COSMOS DELIVERED BY THE LIGHT...

THE RADIUS OF  
THESE RINGS  
IS EQUAL TO THE  
DISTANCE THE  
**SCREAM**  
CAN TRAVEL AND  
IS CALLED  
**SOUND HORIZON**  
...

... AND  
GIVEN THE FACT  
THAT WE, DARK  
MATTER HEAPS,  
ARE SO  
NUMEROUS, THE  
COSMIC SKIN...

... BECAME  
SIMILAR TO THE  
SURFACE OF A  
LAKE HIT BY  
RAINDROPS OR,  
IF YOU PREFER...

... SIMILAR TO THE  
SKIN OF A  
COSMIC  
LEOPARD WITH  
OVERLAPPING  
SPOTS.

AT  
WH  
LIG  
FLO  
FR  
BAR  
MAT  
CAP

... TO T  
GRAVITA  
ATTRACT  
US, HEAPS O  
MATTE

Angel  
Adamo  
1980-2016

Angel  
Adamo  
1980-2016



THIS OVERLAP  
AMONG DIFFERENT  
SPOTS DISTORTS THE  
APPEARANCE OF  
THOSE CIRCUM-  
FERENCES MAKING  
IT VERY DIFFICULT TO  
UNDERSTAND THE  
MUSICAL **SCORE** OF  
THE COSMIC SOUND,  
(BETTER: OF THE  
COSMIC SCREAM.  
TO BE MORE PRE-  
CISE, IT'S A CHOIR  
MADE OF COUNT  
LESS VOICES).

"WHILE OBSERVING STRUC-  
TURE MADE BY GALAXY  
CLUSTERS, YOU ARGUE  
THEY HAVE TO BE CON-  
NECTED SOMEWAY TO THE  
SUBSEQUENT TIME-EVOLU-  
TION OF THOSE OVERDENSE  
CIRCUMFERENCES...

... BUT IT'S REALLY DIFFICULT FOR  
YOU TO GO BACK TO MY FORMER  
POSITION, AS WELL AS THOSE OF ALL  
THE OTHER DARK - MATTER HEAPS,  
TO CONNECT OBSERVED GALAXY  
CLUMPS TO THE SPOTS YOU NOW  
SEE ON THE COSMIC SKIN

TO UNDERSTAND IT, IMAGE SOMEONE ASKS  
YOU TO FIND THE PREPARATORY PENCIL  
SKETCHES OF A PAINTING UNDER MANY CO-  
LOURED LAYERS ON THE CANVAS OF THE  
FINAL PORTRAIT.

*Angelo Adamo*  
INAF-OABO - 20/4/16

"ALL THOSE PENCIL LINES ARE LOST  
IN TIME, LIKE TEARS IN RAIN. (CIT.).

TIME (FOR YOU) TO  
UNDERSTAND.

*Angelo Adamo*  
INAF-OABO - 20/4/16

TIME FOR EUCLID!

THE END



## CONCLUSIONS

- CITIZEN SCIENCE SEEMS PROMISING FOR ANALYSING HUGE DATABASE AS THOSE OF CTA AND SIMILAR FACILITIES. ARE WE SURE THAT THIS APPROACH CAN ONLY PROVIDE AN ASTROPHYSICAL IMPACT?

THIS STRATEGY TO ENGAGE PUBLIC WOULD STRONGLY DEPEND ON HUMAN CAPABILITY OF DISTINGUISHING PARTICULAR SHAPES IN QUITE NOISY CTA IMAGES. THE ANALYSIS OF SUCH AN EFFECT WOULD BE OF PRIMARY IMPORTANCE IN DETERMINING A FIRST-LEVEL BIAS THAT MAY AFFECT THE ZOOTIES' CLASSIFICATION.

THIS STUDY WILL ALLOW US TO CREATE A HUGE DATA-BASE CONCERNING HUMAN VISION IN ORDER TO ESTABLISH THE IMPORTANCE OF PAREIDOLIA IN PATTERN RECOGNITION.

IN ADDITION TO THE POSSIBLE ASTROPHYSICAL RETURN FROM ZOOTIES, WE PROPOSE TO USE THE SKY AS A TOOL TO PROVIDE INSIGHTS ON THE HUMAN BEHAVIOUR.

- NARRATIVE APPROACH AND ENGAGEMENT OF VERY YOUNG PEOPLE

- GREAT DIFFERENTIATION BETWEEN TUTORIAL STYLES: FROM SCIENTIFIC ARTICLE TO OUTREACH ARTICLE, FROM COMICS TO FAIRY TALES: SCIENTIFIC ASPECTS OF NARRATION
- BETTER COMPREHENSION OF NARRATIVE STRUCTURES APPLIED TO SCIENTIFIC TOPICS. A NEW PROPP CLASSIFICATION?

**CHERENZOO: EVALUATION OF BRAIN BIASES AND THE PERSPECTIVE FOR A NEW HUMANISM**

MAYBE WE SHOULD HOPE THAT IN THE FUTURE THE WAY THAT SCIENCE WILL WORK  
WILL BE DIFFERENT:

FOR EVERY SCIENTIFIC PAPER PRODUCT, THERE MUST BE A CARTOON OR OTHER  
OUTREACH WORK THAT EXPLAINS IT, AND BOTH MUST BE SUBMITTED ALONG WITH  
PEER REVIEW



(PROBABLY) THERE'S NO GREAT SCIENCE IF YOU  
AREN'T ABLE TO EXPLAIN IT

MILENIO DE ASTROFISICA (MAS)



[https://www.youtube.com/watch?v=VX\\_q2E5JFMw&list=ULKnuFkTACaWw&index=15](https://www.youtube.com/watch?v=VX_q2E5JFMw&list=ULKnuFkTACaWw&index=15)