

M. Santander - The highest-energy particles in the Universe





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- We expect ultra-highenergy (>10¹⁸ eV) to come from outside our Galaxy.





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- Above a few EeV the Galactic magnetic field is too weak to trap CRs.
- We expect ultra-highenergy (>10¹⁸ eV) to come from outside our Galaxy.
- Detection is a challenge.

























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Active Galactic Nuclei









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Active Galactic Nuclei



Galaxies

Galactic Clusters











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Active Galactic Nuclei

















Cosmic rays with the same energy that we can create on Earth (10 TeV)



Once per second



Cosmic rays with the same energy that we can create on Earth (10 TeV)



Once per second

ANS-02 International Space Station





Cosmic rays with the same energy that we can create on Earth (10 TeV)



Once per second









Direct detection

Time of Flight Z, E











Direct detection

Time of Flight Ζ, Ε



Precision measurement of the positron fraction in CRs.

Signature of dark matter?





TRD Identify e⁺, e⁻



Silicon Tracker



ECAL E of e⁺, e⁻





die un

Direct detection

Direct detection can also be accomplished with high-altitude balloons

a second s

[GeV]

TELL

10²

e positron







Highest-energy cosmic rays





Highest-energy cosmic rays





Highest-energy cosmic rays





Highest-energy cosmic rays



Once per century



Highest-energy cosmic rays



Once per **century**

We need a BIG detector Hundreds or thousands of square miles in size







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Indirect detection

Energetic particles make the air fluoresce in the UV

Can be detected by telescopes on moonless nights

Some particles reach the ground. Recorded by particle detector on the surface.























Terminal 5 🔳

Intrepid Sea, Air 🗃

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HELL'S KITCHEN

21

100

1.1















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Montville

rsippany-Troy Hills

Paterson

Clifton

Bloomfield

East Orange

Irvington

Elizabeth

Linden

STATEN ISLAND

278







Norwalk

•Stamford

Yonkers

New Rochelle

Commack

Hempstead

West Babylon

Massapequa



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Poughkeepsie

84

Danbury

Hartford

Waterbury Middletown

New Haven

Milford

•Huntington

Yonkers

New York

87

Middletown

Brick

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Warwick

6

?

0

Providence

Newport













Cosmic rays up to ~ 100 TeV can be detected directly from space or from baloons.

Higher energies require gigantic

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detectors, thousands of sq. miles in size.





