



# XXXII International Seminar of Nuclear and Subnuclear Physics "Francesco Romano"



# Search for nuclearites with the KM3NeT detector

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# Research activity

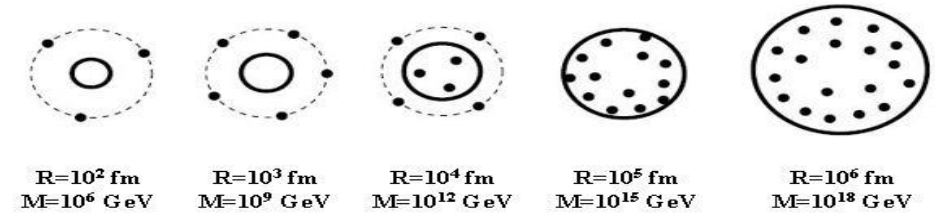
- Studies of nuclearites with the KM3NeT detector
  - ORCA and ARCA configurations
  - Detectors response to massive nuclearite events
  - Sensitivity studies

**MC simulations of nuclearites**



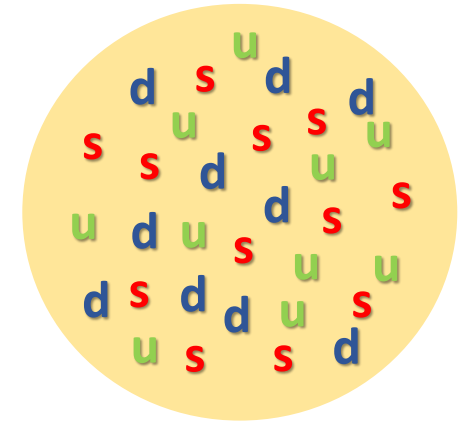
**Simulated data processing**

# Nuclearites



D. Bakari (2000) DFUB 2000-6

- Hypothetical objects (E. Witten 1984)
- Approximately equal quantities of up, down and strange quarks
- Non-relativistic particles
- Elastic and quasi-elastic collisions
- Blackbody radiation in visible
- Violent astrophysical processes in the Universe – neutron star collision
- Could be present in the cosmic radiation



# Nuclearites

- Energy loss

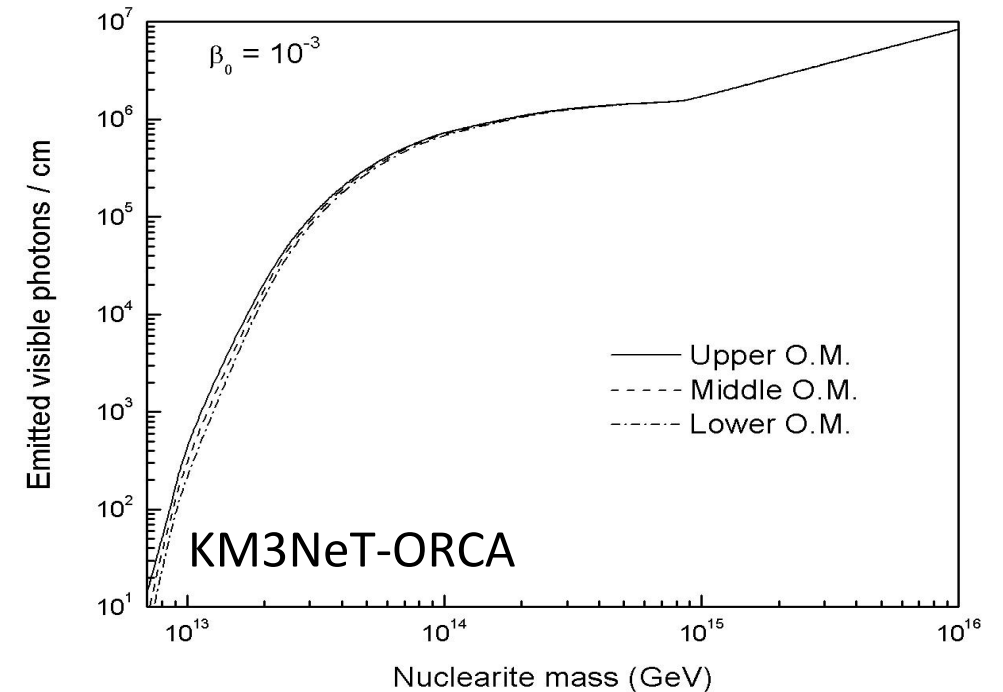
- $\frac{dE}{dx} = -\sigma\rho v^2$

- $\sigma = \begin{cases} \pi \left(\frac{3M}{4\pi\rho_N}\right)^{2/3} \text{ cm}^2, & \text{for } M \geq 8.4 \times 10^{14} \text{ GeV} \\ \pi \times 10^{-16} \text{ cm}^2, & \text{for } M < 8.4 \times 10^{14} \text{ GeV} \end{cases}$

- Emitted visible photons per unit of length

- $\frac{dN_\gamma}{dx} = \eta_{water} \frac{dE/dx}{\langle E_\gamma \rangle} \quad \langle E_\gamma \rangle = 3.14 \text{ eV}, \eta_{water} \approx 3 \cdot 10^{-5}$

A. De Rujula and S. L. Glashow, Nature 312 (1984) 734



The number of emitted visible photons per unit length as a function of nuclearite mass

# KM3NeT detector

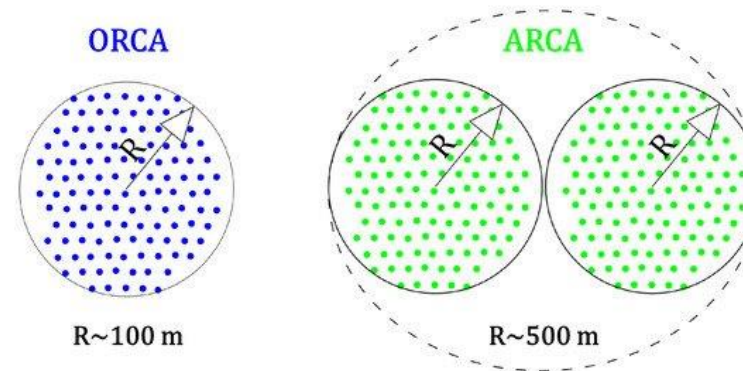
## Oscillation Research with Cosmics in the Abyss

- Mediterranean Sea – France
- Atmospheric  $\nu$
- $\nu$  oscillation
- $\nu$  mass hierarchy determination

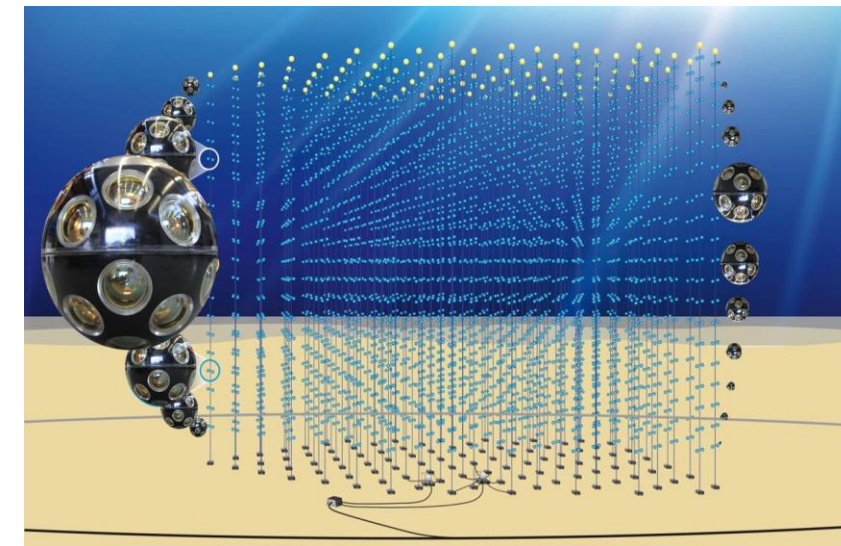
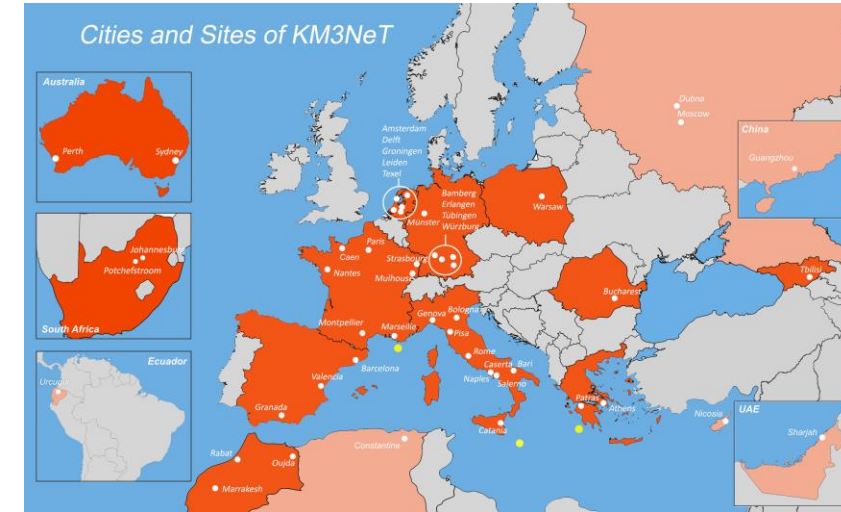
	ORCA	ARCA
Depth (m)	2475	3500
Height (m)	~ 200	~ 700
Radius (m)	~ 100	~ 500
No. of DUs	115	115
No. of DOMs/DU	18	18
No. Of PMTs/DOM	31	31
Distance between DUs (m)	23	95
Distance between DOMs (m)	9	36

## Astroparticle Research with Cosmics in the Abyss

- Mediterranean Sea – Italy
- High energy  $\nu$
- Identification/study of high energy cosmic  $\nu$  sources
- Validation of the  $\nu$  flux measured with IceCube



*Sensors* 2020, 20(18), 5116



<https://www.km3net.org>

## Work completed

- Update of the ANTARES simulation code according to the KM3NeT geometries and PMT characteristics
- Testing of the simulation code
  - Simulation of massive nuclearite events ( $3 \cdot 10^{13} - 10^{17}$  GeV) in ORCA and ARCA configurations
  - Simulated data analysis and interpretation
- Detector response to massive nuclearite events

## Work in progress

- Code integration with the KM3NeT processing software
- Detector sensitivity estimation for nuclearites

## Future plans

- Simulations of nuclearites with background (K40 and bioluminescence)
- Search for possible nuclearite signals in experimental data

