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Search for Primordial Black holes from the International Space Station with the SQM-ISS detector

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In this paper we discuss the observational capabilities and sensitivity of the SQM-ISS detector to primordial black holes.
Primordial black holes are hypothetical black holes that could have formed in the early Universe as a result of density fluctuations in the primordial plasma, and could span a wide range of masses, from microscopic to several solar masses.
Their detection would provide insights into the conditions of the early universe, inflationary scenarios, and could help constrain their possible role as a component of dark matter.
The SQM-ISS experiment aims to detect slow, non relativistic massive particles within cosmic rays, using a detector on board the International Space Station.
The device is designed to recognise the passage of highly penetrating and dense particles in a wide range of mass and charge states.
One particularly interesting candidate is Strange Quark Matter (SQM), which is composed of aggregates of up, down and strange quarks and could represent the fundamental state of hadronic matter.
These particles, travelling at speeds typical of gravitationally bound objects in the galaxy - around 250 km/s - are also possible candidates of dark matter.
The detector can recognise the characteristic signals of these particles by measuring their speed and distance travelled using four plastic scintillator layers read by silicon photomultipliers. Additionally, four interleaved metal plates equipped with piezoelectric sensors detect mechanical vibrations caused by the passage of particles.
The time-of-flight system determines the velocity of particles by recording signals through segmented planes of scintillators. The system can detect objects with travel times up to several 2.5 μs, allowing them to be distinguished from relativistic cosmic rays.The electronics integrate fast analogue-to-digital and time-to-digital converters, with a programmable logic trigger to select relevant events.
The ability of SQM-ISS to identify penetrating, massive and slow-moving objects allows it also to be sensitive to the detection of primordial black holes.
Primordial black holes are thought to have formed in the early Universe due to the collapse of density fluctuations upon reentry into the cosmological horizon during inflationary scenarios.
Alternative mechanisms include the role of cosmic strings, domain walls or phase transitions, which naturally induce peaks in the primordial balck holes mass function.
String theory suggests that primordial balck holes could be interpreted as fuzzballs, horizonless, non-singular objects that do not evaporate like traditional black holes. These fuzzballs emerge from string-theoretic models, such as those involving D-branes or highly excited strings with masses around 10^{17} GeV and a small perturbative coupling. This scenario suggests that Primordial black holes or fuzzballs could be long-lived and contribute to dark matter, avoiding complete evaporation via Hawking radiation.
If black holes evaporate by emitting Hawking radiation, the surviving ones should have a mass greater than 10^{11} g.
SQM-ISS will explore a range of low-mass PBHs ($10^9 - 10^{15}$ g), providing new constraints on their abundance and potential connection to dark matter.

We will discuss how black holes, travelling through the detector at velocities compatible with galactic orbital speeds, can be identified based on their interaction signatures.
Their detection would confirm the existence of low-mass PBHs, and the absence of signals would set new experimental limits and guide future research on this class of exotic objects.

Eligibility for "Best presentation for young researcher" or "Best poster for young researcher" prize

Yes

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