Properties of Cosmic Beryllium Isotopes Measured by the Alpha Magnetic Spectrometer

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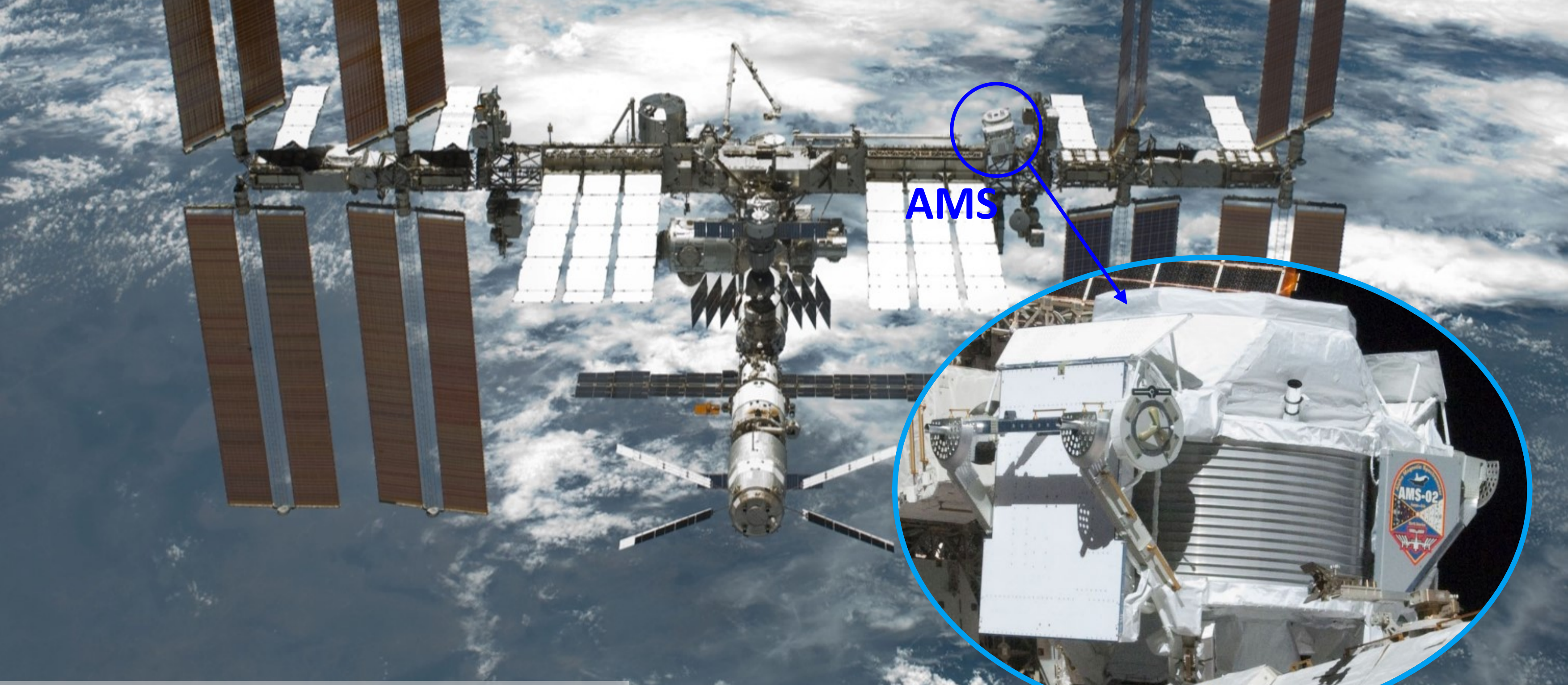


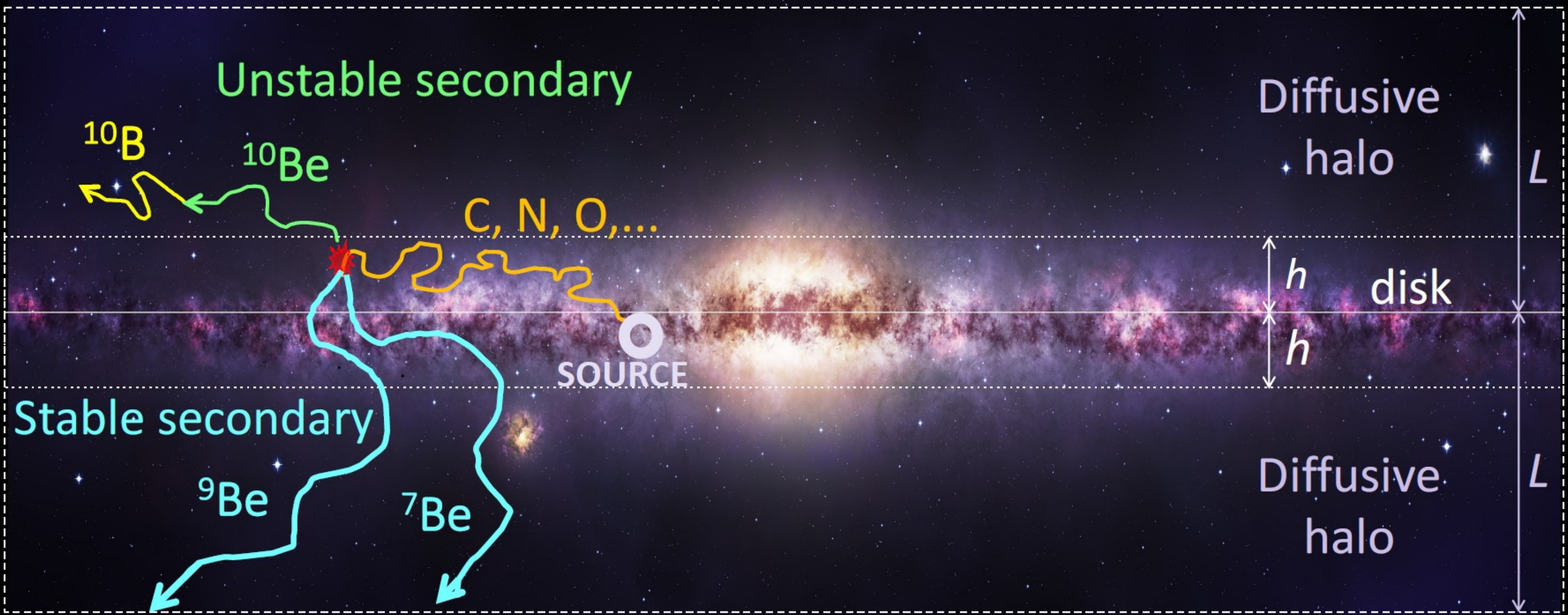
16th July 2026 @Guangzhou

The Production and Propagation of Cosmic Beryllium Nuclei

Cosmic beryllium: Secondary cosmic rays;
The dominant source is the fragmentation of carbon and oxygen nuclei.

Cosmic-ray beryllium has 3 isotopes: ^{7}Be, ^{9}Be, and ^{10}Be

^{7}Be decays by electron capture to ^{7}Li, but since it stays fully ionized during propagation, it is effectively stable above a few tens MeV/n. ^{9}Be is a stable nucleus. ^{10}Be decays via β^{-}-decay to ^{10}B with a half-life of 1.387 ± 0.012 Myr.



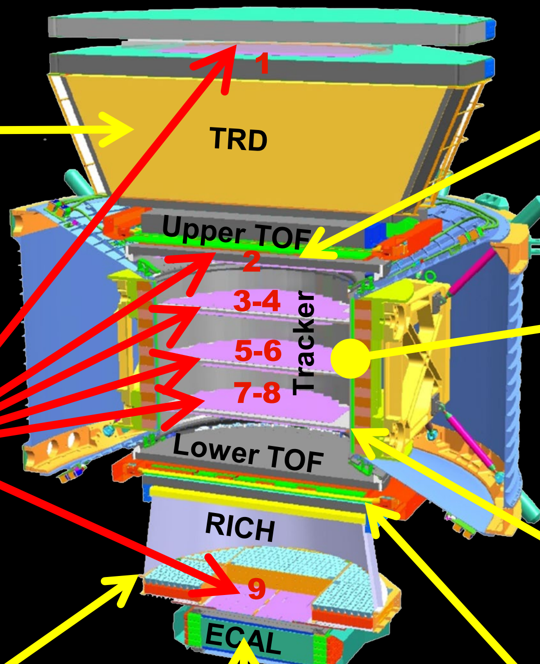
The precise measurements of cosmic Be isotopes provide unique information on cosmic-ray propagation parameters.

AMS is a Space Version of a Precision Detector Used in Accelerators

Transition Radiation Detector (TRD)
identify e^+, e^-

Silicon Tracker
measure Z, P

Ring Imaging Cerenkov (RICH)
measure Z, E

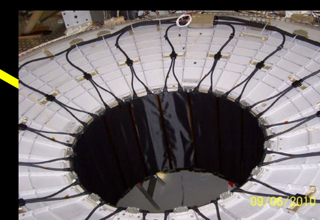


Electromagnetic Calorimeter (ECAL)
measure E of e^+, e^-

Upper TOF measure Z, E

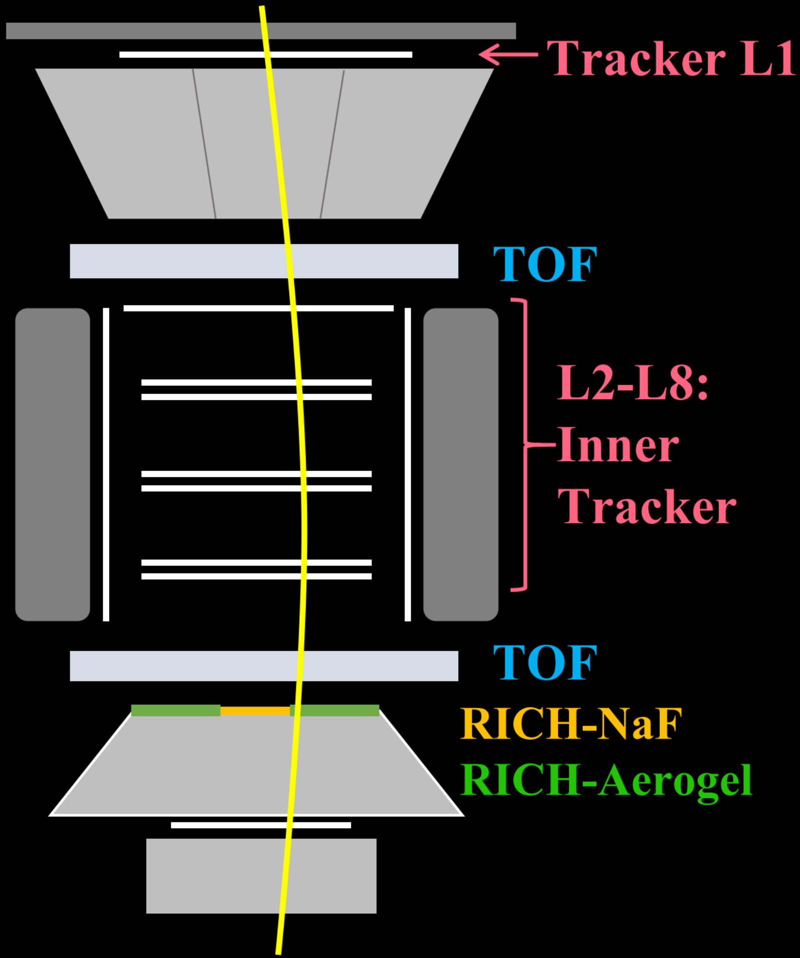
Magnet identify ±Z, P

Anticoincidence Counters (ACC)
reject particles from the side



Lower TOF
measure Z, E

Key Detectors for the Measurement of Be Isotopes



AMS mass resolution depends on rigidity ($R = P/Z$) and velocity (β) resolutions:

$$M = \frac{RZ}{\beta\gamma}$$

$$\gamma = 1/\sqrt{1-\beta^2}$$

Z measurement:

L1 - UTOF - Inner Tracker - LTOF

R measurement :

Tracker $\Delta R/R \sim 10\%$ for $R < 20GV$

β measurements :

Time of Flight: TOF (4 layers)

Ring Imaging Cherenkov - NaF

$$\beta = v/c > 0.75$$

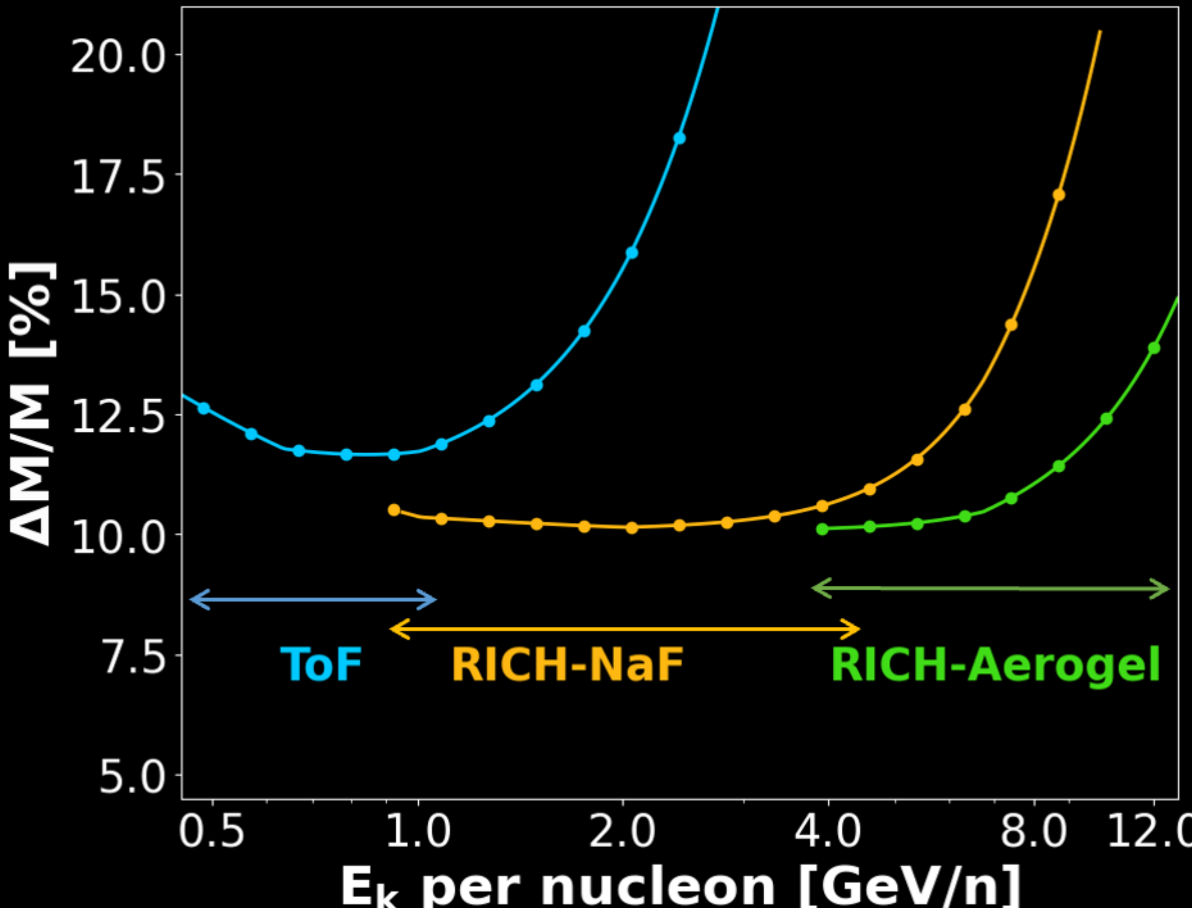
Ring Imaging Cherenkov – Aerogel

$$\beta = v/c > 0.95$$

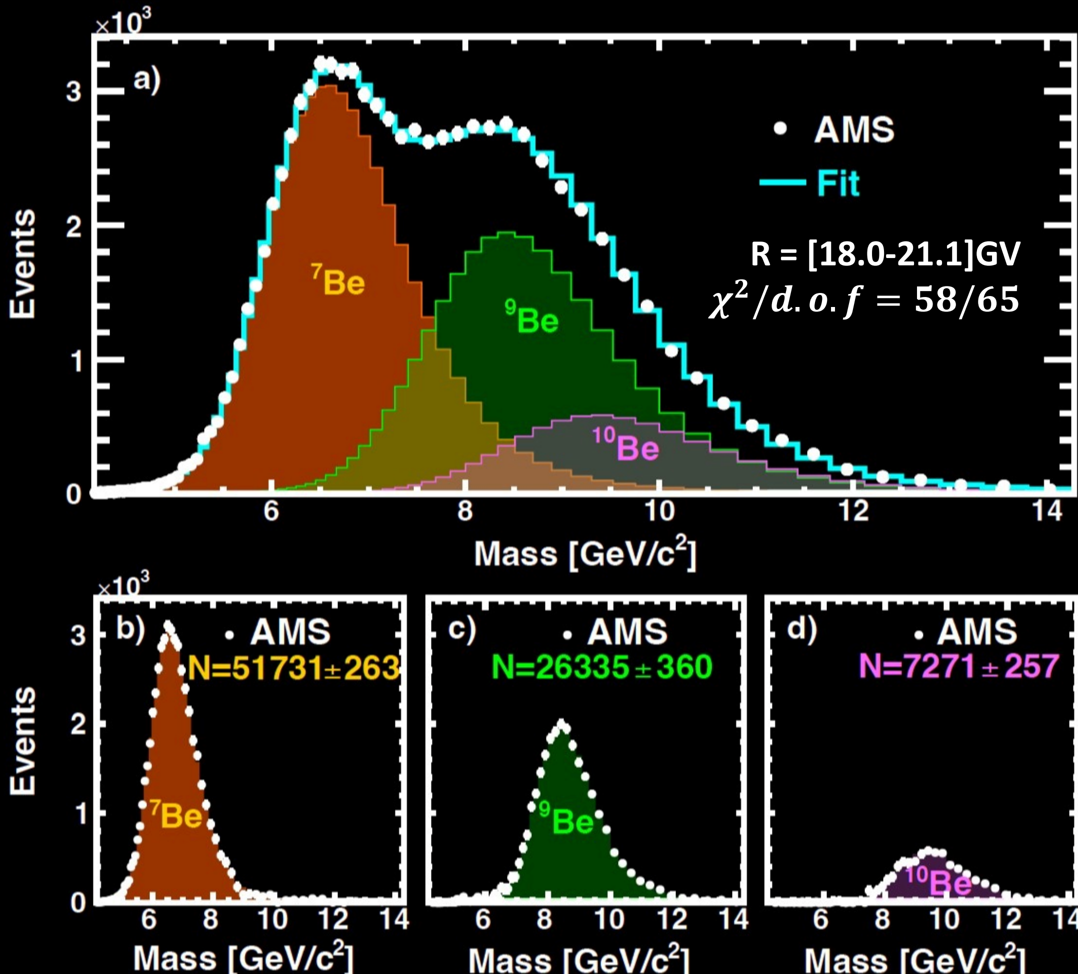
Beryllium Mass Resolution

The mass resolution can be described by:

$$\Delta M/M = \sqrt{(\sigma_R/R)^2 + \gamma^4(\sigma_\beta/\beta)^2}$$



Events of Beryllium Isotopes: ^{7}Be, ^{9}Be, and ^{10}Be

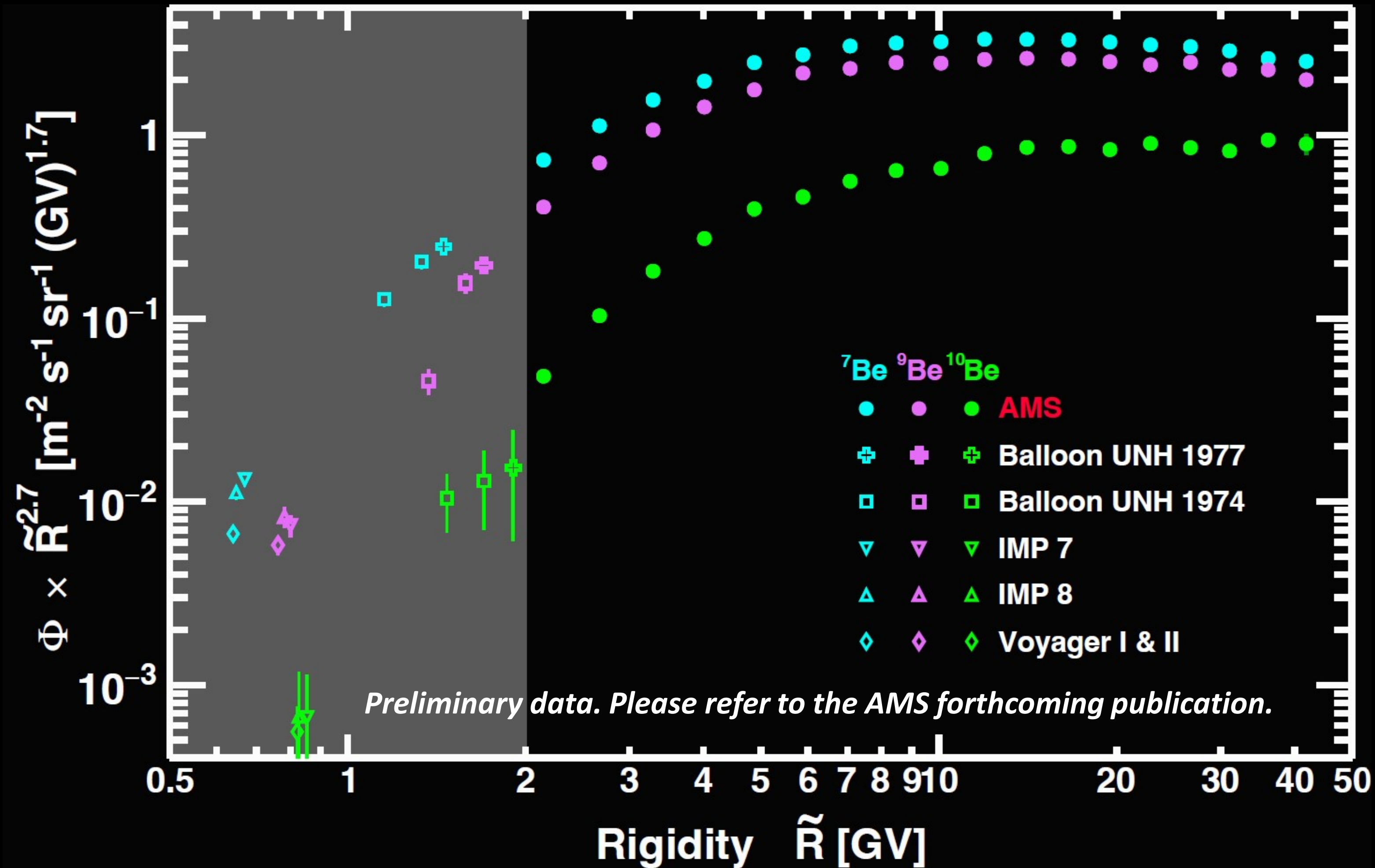


The number of events for the 3 isotopes are obtained by fitting the measured mass distribution with ^{7}Be, ^{9}Be, and ^{10}Be mass templates.

The analysis is based on 0.62M ^{7}Be, 0.42M ^{9}Be, and 0.11M ^{10}Be events collected by AMS continuosly for 14.5 years, from May 2011 to November 2025.

Preliminary data. Please refer to the AMS forthcoming publication.

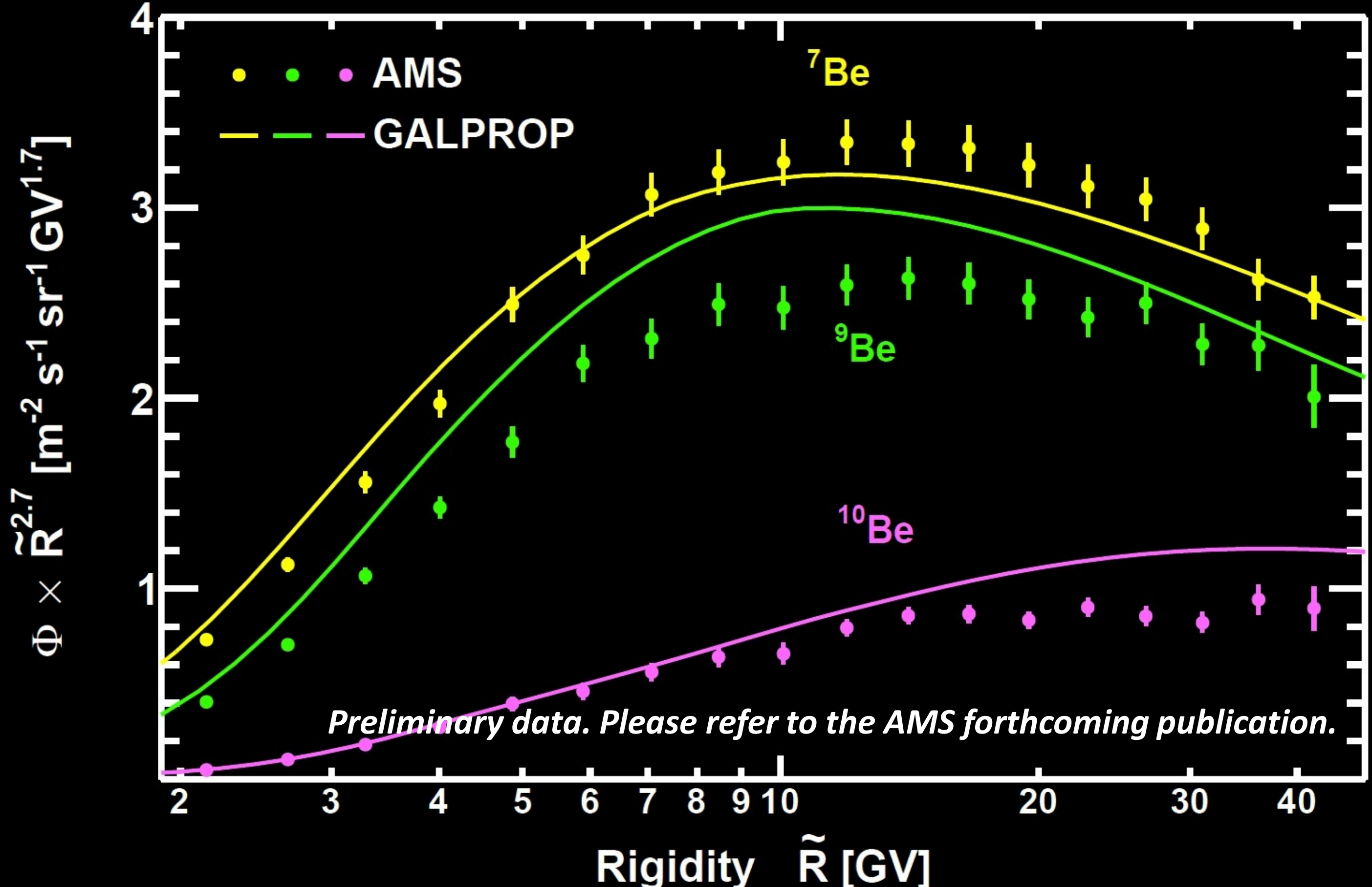
Fluxes of Beryllium Isotopes: ^{7}Be, ^{9}Be, and ^{10}Be



The isotropic flux $\Phi_i^{A_{Be}}$ in the ith rigidity bin $(R_i, R_i + \Delta R_i)$ is given by:

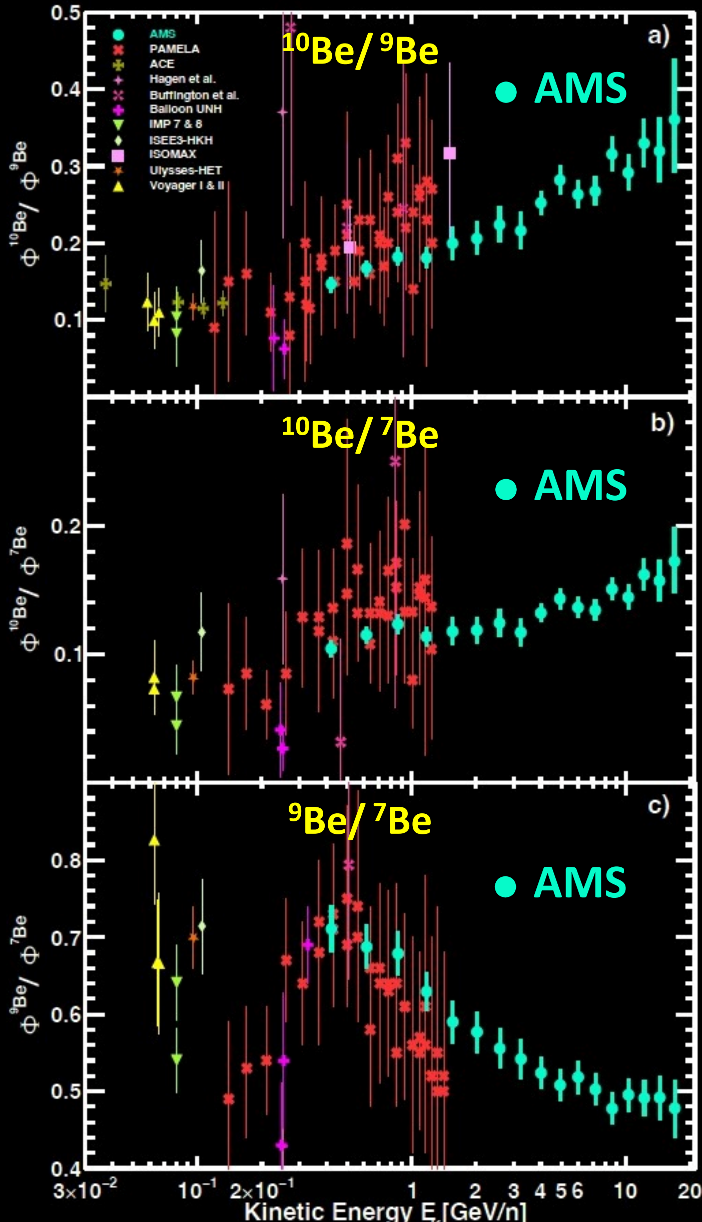
$$\Phi_i^{A_{Be}} = \frac{N_i^A}{A_i^A \epsilon_i \Delta R_i T_i}$$

The Prediction of GALPROP Model for ^{7}Be, ^{9}Be, and ^{10}Be Fluxes



In this analysis, GALPROP are computed by using 4 kpc halo size with solar modulation in the Force Field Approximation for the AMS data taking period. As seen, the latest GALPROP model provides a qualitative prediction of the AMS results.

The Be Flux Ratios: $\Phi^{a_{Be}}/\Phi^{b_{Be}}$



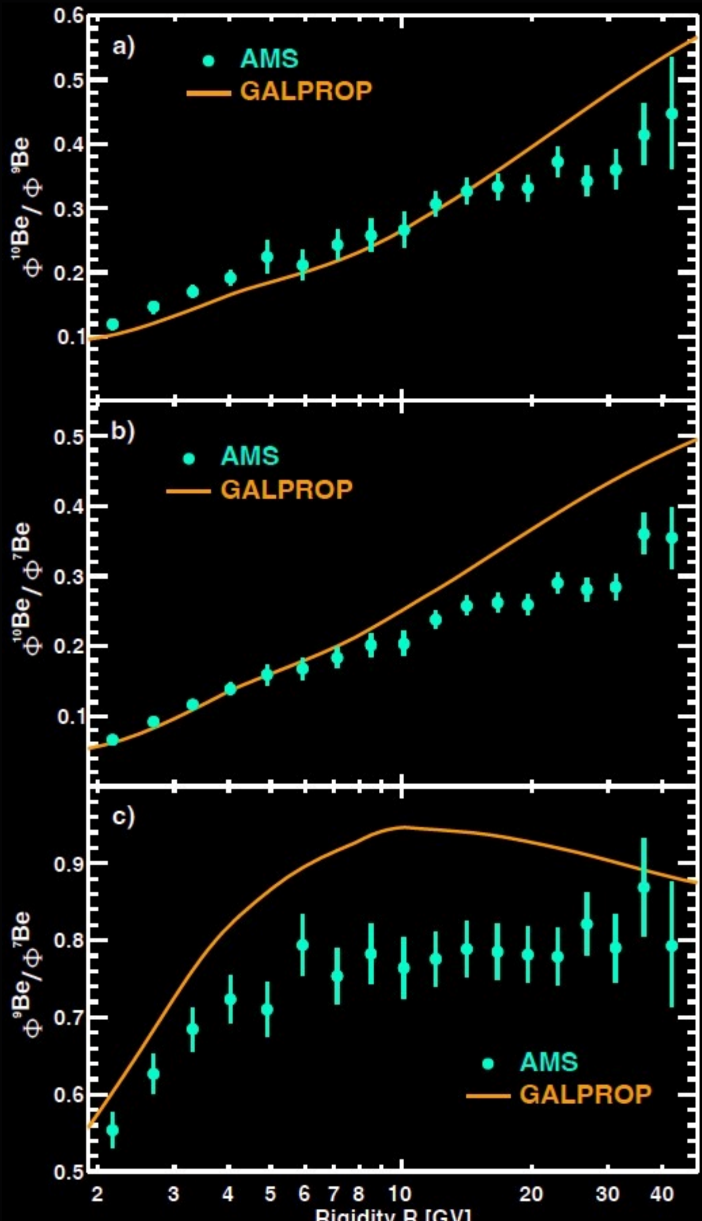
Preliminary data. Please refer to the AMS forthcoming publication.

Over the past 50 years, balloon and satellite experiments have measured the $\Phi^{10_{Be}}/\Phi^{9_{Be}}$, $\Phi^{10_{Be}}/\Phi^{7_{Be}}$, and $\Phi^{9_{Be}}/\Phi^{7_{Be}}$ in kinetic energy per nucleon below 2 GeV/n with uncertainties exceeding 40%.

The AMS measured the flux ratios as a function of the kinetic energy per nucleon, E_k, from 0.34 to 18 GeV/n. The total errors are greatly reduced.

For $\Phi^{10_{Be}}/\Phi^{9_{Be}}$ and $\Phi^{10_{Be}}/\Phi^{7_{Be}}$, above ~1.5 GeV/n the ratios increase with the energy due to relativistic time dilation of the decay of ^{10}Be.

The Prediction of GALPROP Model for $\Phi^{a_{Be}}/\Phi^{b_{Be}}$

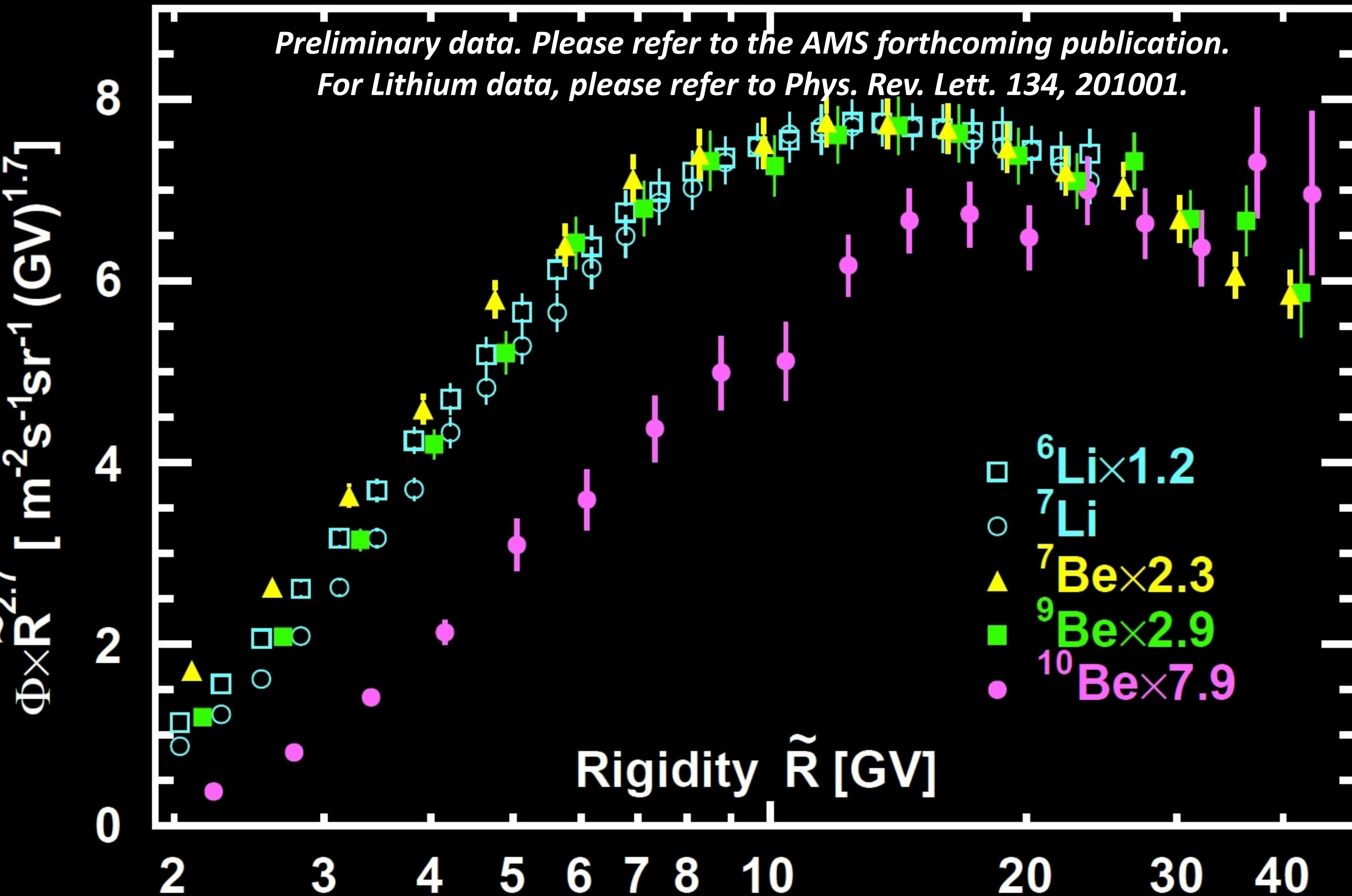


Preliminary data. Please refer to the AMS forthcoming publication.

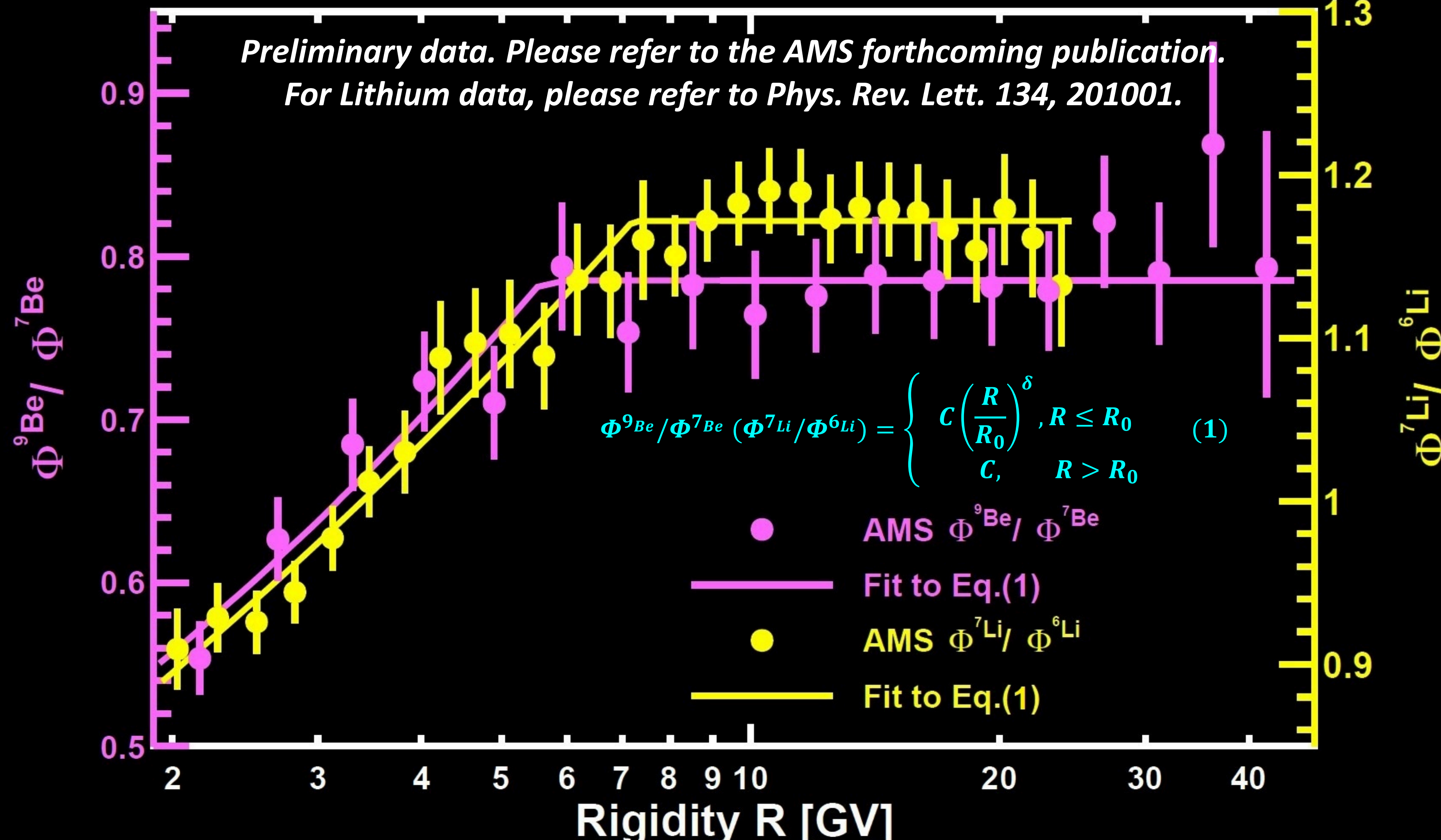
The orange curves show predictions from the latest GALPROP model using 4 kpc halo size with solar modulation in the Force Field Approximation for the AMS data taking period.

As seen, the latest GALPROP model provides a qualitative prediction of the AMS results.

Comparison between $\Phi^{A_{Be}}$ and $\Phi^{A_{Li}}$



Comparison between $\Phi^{^9Be}/\Phi^{^7Be}$ and $\Phi^{^7Li}/\Phi^{^6Li}$



$\Phi^{^7Be}$ and $\Phi^{^9Be}$ have an identical rigidity dependence above $\sim 6\ GV$. The $\Phi^{^7Li}/\Phi^{^6Li}$ and $\Phi^{^9Be}/\Phi^{^7Be}$ exhibit similar rigidity dependence.

Conclusion

- The measurements of AMS on ^{7}Be, ^{9}Be, and ^{10}Be as well as $\Phi^{10_{Be}}/\Phi^{9_{Be}}$, $\Phi^{10_{Be}}/\Phi^{7_{Be}}$, and $\Phi^{9_{Be}}/\Phi^{7_{Be}}$ from May 2011 to November 2025 in the rigidity range from 2 GV to 45 GV have been presented.

- The latest GALPROP model provides a qualitative prediction for $\Phi^{7_{Be}}$, $\Phi^{9_{Be}}$, and $\Phi^{10_{Be}}$, as well as $\Phi^{10_{Be}}/\Phi^{9_{Be}}$, $\Phi^{10_{Be}}/\Phi^{7_{Be}}$, and $\Phi^{9_{Be}}/\Phi^{7_{Be}}$.

- $\Phi^{9_{Be}}/\Phi^{7_{Be}}$ rigidity dependence shows $\Phi^{7_{Be}}$ and $\Phi^{9_{Be}}$ have an identical rigidity dependence above $\sim 6\ GV$. $\Phi^{7_{Li}}/\Phi^{6_{Li}}$ and $\Phi^{9_{Be}}/\Phi^{7_{Be}}$ exhibit similar rigidity dependence.