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Systematic of New Isotopic Production Cross Sections from Neon Projectiles

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Abstract

New isotopic production cross sections from ^{22}Ne projectiles at 377, 581 and 891 MeV/nucleon in a liquid hydrogen target have been measured by the *Transport Collaboration* at the LBL HISS facility. These data allow us to investigate the projectile energy and nuclear composition dependence of the cross sections. The comparisons between data and predictions can have important consequences in galactic cosmic ray propagation as well as in source abundance investigations.

1 Introduction

The Transport Collaboration, consisting of researchers *from* institutions in France, Italy, and the USA, has established a program to make new measurements of projectile fragmentation cross sections for heavy ions($Z\geq2$) in a liquid hydrogen target. Such cross sections directly affect calculations of galactic cosmic ray transport through interstellar matter. To date, the collaboration has obtained data using the LBL Bevalac HISS facility with our liquid hydrogen target for 20 projectile-energy systems. Data currently under analysis cover projectiles from ^{4}He to ^{58}Ni and accelerator kinetic energies from 393 MeV/nucleon to 910 MeV/nucleon. Here we present preliminary isotopic production cross sections from the fragmentation of ^{22}Ne + H with energies of 377, 581 and 894 MeV/nucleon at the center of the target. A detailed description of the experimental setup used, as well as the data analysis techniques and procedures, can be found in Engelage et al.[1], Chen et aL[2], Knott et al.[3], and Tull et al.[4] Briefly, by using the full capability of HISS, we measure the charge, rigidity, and time of flight of each projectile fragment, thereby completely identifying the fragment isotope (Z_f, A_f) on an event-by-event basis. Using the first-order relation between fragment rigidity and bending angle of the fragment trajectory through the HISS dipole, we have obtained a mass resolution of A=O.15-O.25 amu for fragments of ^{22}Ne.

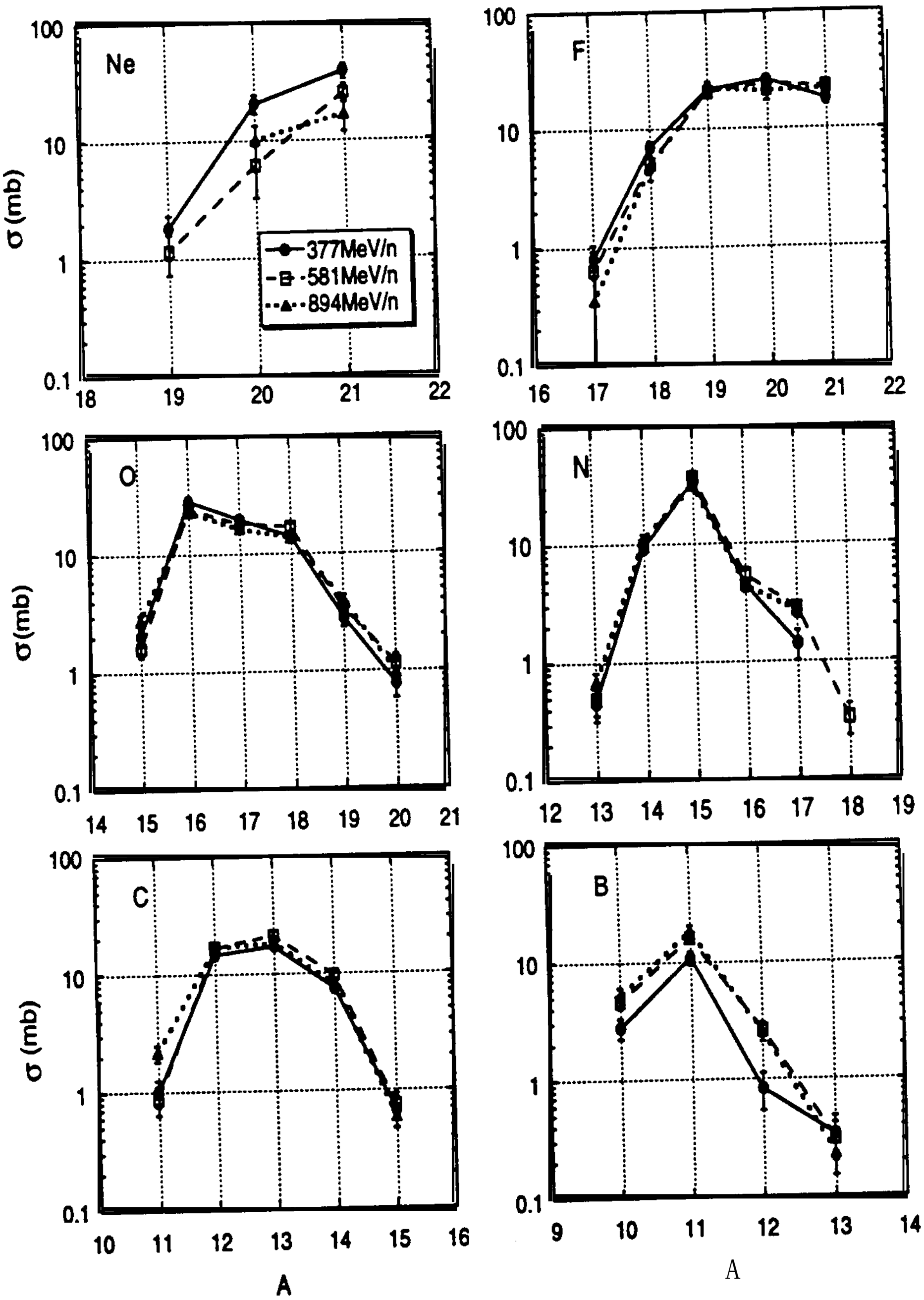

Figure 1. Individual isotopic production cross sections from ^{22}Ne projectile at 377, 581, and 894 MeV/nucleon.

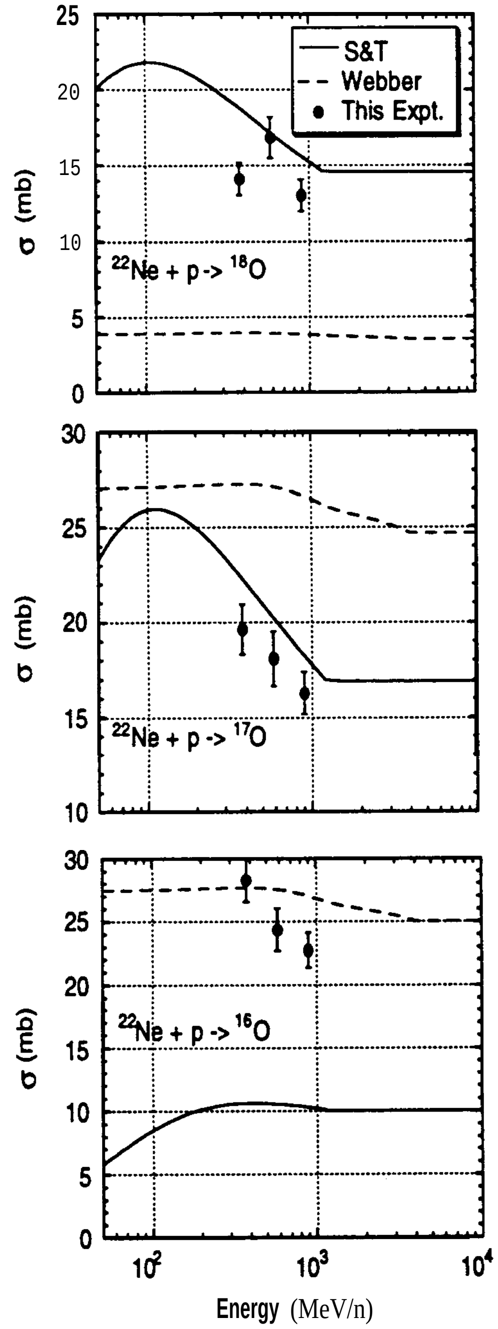

Figure 2. Energy dependencies of individual isotopic cross sections for three oxygen isotopes.

2 Results and Discussions

Isotopic production cross sections for **^{22}Ne + H at three energies have been** calculated using the entire entire set available and are plotted in Figure 1. Preliminary analysis of these cross sections suggests a number of systematic features of the new measurements. In general, the isotopic cross sections from all three energies trace each other well. The usual gaussian mass distribution within each element is ***not the*** predominant feature for ^{22}Nc, a neutron-rich projectile. Compared to the neutron-**balanced ^{20}Ne data (see Webber et al. [5]),** the usually strong ^{16}O peak is subdued **while ^{17}O and ^{18}O are enhanced. Also,** there is a particularly large production of **^{15}N and ^{11}B. This indicates that the** isospin of the original ^{22}Ne projectile significantly influences the fragmentation process. There are energy dependencies for both elemental and isotopic productions. The low energy beam shows a relatively **larger productions of small Δz fragments** such as fluorine, along with neutron-stripped neon isotopes. However for large **Δz fragments such as carbon and boron, the** higher energy beams have larger production cross sections. Within individual elements, the neutron rich isotopes are enhanced at higher energy, similar to what has been **observed in ^{32}S data (Tull et al. [4]).**

The comparisons between data and cross section predictions are shown in Figure 2 for the three oxygen isotopes as examples. **The ^{18}O result is slightly below the** Silberberg and Tsao (S&T) semi-empirical predictions[6], but is a factor of 3-4 higher then the Webber parametric predictions[7]. **The ^{17}O result is slightly below the S&T** predictions, with the same energy trend, and -30% below the Webber predictions. The **^{16}O result, however, is a total reversal of the ^{18}O comparison. Our result is slightly** below the Webber predictions, but is a **factor of ~2.5 higher than the S&T** predictions. Therefore, neither the S&T nor the Webber predictions alone agrees consistently with the oxygen results from ^{22}Ne projectile. The large discrepancies between the data and predictions for ^{18}0 and ^{16}0, along with fluorine and nitrogen data, mean that the resultant cosmic ray ^{18}0/^{16}0 ratio calculation using new cross sections will be reduced compared to the S&T predication but will be enhanced compared to the Webbcr prediction (see Guzik et al.[8]).

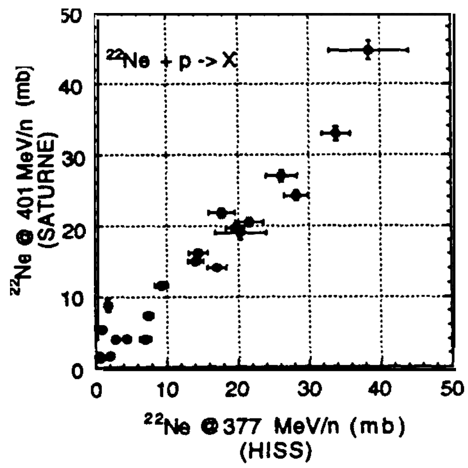

Figure 3. Comparison between HISS (this experiment) and SATURNE (Webber et al.) data.

The recent measurement of ^{22}Ne on a hydrogen target at 401 MeV/nucleon by Webber et al.[9] at SATURNE offers a unique opportunity to compare and to validate the same cross sections from two different accelerator facilities and obtained using different experimental techniques. In Figure 3 we plot a general cross comparison for the two data sets. To first order, the two sets of cross sections agree with each other very well. A detailed study of both data sets will enable us to not only cross check the final results but also investigate the systematic of each individual experiment.

3 Conclusions

We reporti in a preliminary comparison of ^{22}Ne projectile fragmentation in hydrogen at 377, 581, and 891 MeV/nucleon, systematic differences that indicate nuclear structure effects in the isotopic production cross sections. The new isotopic cross sections from ^{22}Ne, a neutron rich species, behave differently from its neutron-balanced counterpart. The cross sections differ considerably from both S&T and Webber predictions in many instances, Overall, the richness of the new data will provide much needed information to study cross sections systematic, whith in turn will yield better predictions for the unmeasured interaction channels. This will certainly impact significantly upon galactic cosmic ray propagation and source abundance investigations.

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