Precise mass measurements of proton-rich refractory metals and nuclides near the termination of the rp-process path

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To describe the observed properties of x-ray bursts, models require a vast amount of empirical data for the thousands of nuclear reactions which occur in these environments. Measurements of β-decay half-lives, energy levels which can be thermally populated, and masses are all essential. Masses of "waiting-point" nuclei are particularly significant since the photodisintegration rates, which are exponentially dependent upon mass differences, outweigh the proton-capture rates and the creation of heavier elements through this process of rapid proton-capture reactions, termed the rp-process, stalls. The Canadian Penning Trap mass spectrometer at the ATLAS facility of Argonne National Laboratory has been used to determine the masses of a number of nuclides along the rp-process path, including most notably the two waiting-point nuclei ^{68}Se and ^{64}Ge. More recently, we have determined the masses of more than 16 nuclides within two important regions along the rp-process path: nuclides of proton-rich In, Sn, and Sb in the vicinity of the rp-process path termination, and refractory metals where very little experimental mass information is available. When compared with the FRDM mass model, which is often used as a source of mass information in x-ray burst models, we find our measurements differ by as much as 600 keV. This paper will report the measured masses, compare the results to mass models commonly used by x-ray burst models, and discuss the implications of the new masses for the rp-process.