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A Black Hole and Its Metal-Poor Companion: A Full Chemical Analysis of the Red Giant in Gaia BH3

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Gaia BH3 is the third black hole that was discovered with in the early data release in Gaia DR4 due to the astrometric implication of a ~33 solar mass companion of a red giant. This red giant companion is an old metal-poor star that is likely a part of the Sequoia halo substructure. The possible production mechanisms for this binary system and the initial detection of Eu in this star (Gaia Collaboration et al. 2024) made this red giant companion a prime target to follow-up. Here we present a full chemical abundance analysis of the red giant companion in Gaia BH3 with ~40 hours of observations on the Tull Coudé Spectrograph on the 2.7 Harlan J. Smith Telescope at McDonald Observatory. We confirm the presence of neutron capture elements as well as the detection of Li. We attempt to use the r-process elements detected in this red giant to place an age on this system. The presence of these heavy elements in this ~33 solar mass black-hole and red giant binary has implications about the formation of this peculiar system and can help us constrain the environments that produce neutron-capture elements. These observations lay the groundwork for heavy element chemical analysis for subsequent black-hole and stellar binaries that will likely be found in Gaia DR4.

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