Understanding Giant Radio Galaxy J1420-0545: Large-Scale Morphology, Environment, and Energetics

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In this paper we consider the possibility that the structure of the largest radio galaxy J1420-0545 is formed by a restarted rather than a primary jet activity. This hypothesis is motivated by the unusual morphological properties of the source, suggesting almost ballistic propagation of powerful jets in a particularly low-density environment. New radio observations of J1420-0545 confirm its morphology consisting of only two narrow lobes; no trace of any outer low-density cavity due to the previous jet activity is therefore detected. Different model fits performed using the newly accessed radio data imply relatively young age of the source, its exceptionally high expansion velocity, large jet kinetic power, and confirm particularly low-density environment. We find that it is possible to choose a realistic set of the model parameters for which the hypothetical outer lobes of J1420-0545 are old enough so that their expected radio surface brightness is substantially below the rms noise level of the available radio maps. On the other hand, the extremely low density of the gas surrounding the J1420-0545 lobes is consistent with the mean density of the baryonic matter in the Universe. This suggests that the source may be instead located in a real void of the galaxy and matter distribution. In both cases the giant radio lobes of J1420-0545 are expected to modify substantially the surrounding matter by driving strong shocks and heating the gas located at the outskirts of the filamentary galactic distribution. Finally, we also find that the energetic requirements for the source are severe in terms of the total jet power and the total energy deposited by the outflows far away from the central engine.

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