Analysis of Ring Galaxies Detected Using Deep Learning With Real and Simulated Data

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Understanding the formation and evolution of ring galaxies, galaxies with an atypical ring-like structure, will dramatically improve understanding of black holes and galaxy dynamics as a whole. Current catalogs of rings are extremely limited: manual analysis takes months to accumulate an appreciable sample of rings and existing computational methods are vastly limited in terms of accuracy and detection rate. Without a sizable sample of rings, further research into their properties is severely restricted. This project investigates the usage of a convolutional neural network (CNN) to identify rings from unclassified samples of galaxies. A CNN was trained on a sample of 100,000 simulated galaxies, transfer learned to a sample of real galaxies and applied to a previously unclassified dataset to generate a catalog of rings which was then manually verified. The properties of these galaxies were then estimated from their photometries. A catalog of 580 ring galaxies, the current largest set of computationally identified rings, was extracted with 6.6 times the accuracy, 7.8 times the detection rate, and 53.7 times the time efficiency of conventional computational methods. The null hypothesis that the specific star formation rates of the ringed and non-ringed identifications were from the same distribution was rejected with a p-value of .015, agreeing with prior studies. With upcoming surveys such as the Vera Rubin Observatory Legacy Survey of Space and Time obtaining images of billions of galaxies, this model could be crucial in classifying large populations of rings to better understand the peculiar mechanisms by which they form and evolve.

Awards Won:
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: Full Scholarship from King Fahd University of Petroleum and Minerals(KFUPM) (and a $400 cash prize)
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: NOT TO BE READ -- $400 cash prize for each Full Scholarship from King Fahd University award recipient
Patent and Trademark Office Society: Second Award of $500