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Identifying Exoplanets with Deep Learning: Removing Stellar Activity Signals from Radial Velocities Using Neural Networks[1] ZOE L DE BEURS, The University of Texas at Austin, ANDREW VANDERBURG, University of Wisconsin-Madison, CHRISTOPHER J SHALLUE, Center for Astrophysics — Harvard & Smithsonian, HARPS-N COLLABORATION — Exoplanet detection with precise radial velocity (RV) observations is currently limited by spurious RV signals introduced by stellar activity. Here we show that machine learning techniques (linear regression, neural networks) can effectively remove these activity signals from RV observations. Previous efforts have focused on carefully filtering out activity signals in time using Gaussian process regression (e.g. Haywood et al. 2014). Instead, we separate activity signals from true center-of-mass RV shifts using only changes to the average shape of spectral lines, and no information about when the observations were collected. We demonstrate our technique on simulated data, reducing the RV scatter from 82.0 cm/s to 3.1 cm/s, and on approximately 700 observations taken nearly daily over three years with the HARPS-N Solar Telescope, reducing the RV scatter from 1.47 m/s to 0.78 m/s (a factor of ~ 1.9 improvement). In the future, these or similar techniques could remove activity signals from observations of stars outside our solar system and eventually help detect habitable-zone Earth-mass exoplanets around Sun-like stars. In this way, improvements in RV precision could significantly accelerate the characterization of habitable zone Earth-sized exoplanets.

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