UNDERSTANDING THE DIVERSITY OF ROCKY BODIES FROM WHITE DWARF POLLUTION. W. Feng[1] and S. Desch[1], [1]School of Earth and Space Exploration, Arizona State University (wanda.feng@asu.edu, steve.desch@asu.edu).

Introduction: Approximately 30% of white dwarfs (WDs) show heavy elements which should gravitationally settle out of their atmospheres, leaving hydrogen and helium [1]. The prevailing hypothesis for this heavy element "pollution" invokes the accretion of rocky bodies that are tidally disrupted to form circumstellar disks [2]. New insights to the bulk chemistry and diversity of extrasolar rocky bodies may be gained by observing heavy elements in WD atmospheres.

The disk accretion scenario is key to understanding the rocky bodies that pollute WDs. A disk of solid particles forms when a rocky body falls within the WD Roche radius and the particles are subsequently transported inward by Poynting-Robertson drag [3-4]. At high temperatures close to the WD, solid particles sublimate to gas that accretes onto the WD and viscously spreads outward. Current models can explain the accretion rates derived from observations if the gas viscously spreads at rates consistent with partially suppressed magnetorotational instability (MRI) [4]. However, disk chemistry and dust-to-gas mixing for various sources of ionization are not considered in this assumption. We present ionization fractions for thermal and non-thermal processes to assess the extent of MRI in WD disks.

Methods: The presence of water in WD disks has been deduced from oxygen excess after converting elemental abundances to their oxide forms [6]. By assessing disk chemical compositions inferred from spectra [6-7], we estimate that WD disks are comprised of 10 wt% water. Considering the sublimation temperature of water ice, 130 K [8], with the blackbody definition of disk temperature, it is evident that pure water ice would sublimate before the rocky body falls within the Roche radius. If water instead takes the form of phyllosilicates like serpentine, which dehydrates at 900 K [9], then water vapor may be present in WD disks.

For MRI to operate, WD disks must be at least partially ionized to dynamically couple the gas to magnetic fields. Critical ionization is the electron fraction below which Ohmic dissipation will suppress MRI and the disk viscosity parameter, $\alpha = 0$. We compare this to ionization fractions that result from exposure to UV, X-rays, and high-temperature.

WDs emit strongly in the UV, which can ionize water molecules. The ionization fraction due to UV can be derived by balancing the number of absorptions and recombinations per volume per time. We calculate the column densities at which the UV ionization fraction becomes critical. For context, one of the most heavily polluted WDs has a total column density $N_{H2O} \approx 10^{22}$ cm^{-2}. By taking a mass-weighted average where the top ionized layer may have up to $\alpha = 0.1$ (typical of compact disks) and everything below has $\alpha = 0$, we estimate α if UV were the dominant ionization source in WD disks.

X-rays have been shown to ionize protoplanetary disks [11]. WD X-ray luminosities are significantly lower than young stellar objects, however we calculate the ionization fraction due to X-rays and show that this effect is non-negligible. As with UV ionization, we calculate the column densities at which the X-ray ionization fraction becomes critical and estimate the disk α.

The inner edges of protoplanetary disks are thought to sustain thermal ionizations where the temperature is high enough to ionize gas-phase alkali metals like potassium [12-13]. [14] show that high-temperature ionization depends on the work function of solid grains rather than the ionization potential of alkali atoms. We calculate the temperature at which the electron density by high-temperature ionization becomes critical.

Results and Conclusions: The disk viscosity parameter α for UV, X-ray, and high-temperature ionization of WD disks are 10^{-9}, 10^{-2}, and 0.1 at temperatures greater than 700 K. MRI in WD disks must be carefully modeled - we will present this in a subsequent paper.

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