The Role of Evolutionary Age and Metallicity in the Formation of Classical Be Circumstellar Disks II. Assessing the Evolutionary Nature of Candidate Disk Systems

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We present the first detailed imaging polarization observations of six SMC and six LMC clusters, known to have large populations of B-type stars which exhibit excess H$alpha$ emission, to constrain the evolutionary status of these stars and hence better establish links between the onset of disk formation in classical Be stars and cluster age and/or metallicity. We parameterize the interstellar polarization (ISP) along the lines of sight to these twelve clusters, thereby providing a diagnostic of the fundamental properties of the dust which characterizes their localized interstellar medium. We determine that the ISP associated with the SMC cluster NGC 330 is characterized by a modified Serkowski law with $lambda_{max}$ sim4500AA, indicating the presence of smaller than average dust grains. Furthermore, the morphology of the ISP associated with the LMC cluster NGC 2100 suggests that its interstellar environment is characterized by a complex magnetic field.

Removing this interstellar polarization component from our data isolates the presence of any intrinsic polarization; the wavelength dependence of this intrinsic polarization provides a diagnostic of the dominant and any secondary polarigenic agents present, enabling us to discriminate pure gas disk systems, i.e. classical Be stars, from composite gas plus dust disk systems, i.e. Herbig Ae/Be or B[e] stars. Our textit{intrinsic} polarization results, along with available near-IR color information, strongly supports the suggestion of Wisniewski et al. that classical Be stars are present in clusters of age 5-8 Myr, and contradict assertions that the Be phenomenon only develops in the second half of a B star's main sequence lifetime, i.e. no earlier than 10 Myr. Our data imply that a significant number of B-type stars must emerge onto the zero-age-main-sequence rotating at near-critical rotation rates, although we can not rule out the possibility that these data instead reveal the presence of a sub-group of the Be phenomenon characterized by sub-critically rotating objects.

Comparing the polarimetric properties of our dataset to a similar survey of Galactic classical Be stars, we find that the prevalence of polarimetric Balmer jump signatures decreases with metallicity. We speculate that these results might indicate that either it is more difficult to form large disk systems in low metallicity environments, or that the average disk temperature is higher in these low metallicity environments. We have characterized the polarimetric signatures of all candidate Be stars in our data sample and find sim25% are unlikely to arise from true classical Be star-disk systems. This detection of such a substantial number ``contaminants'' suggests one should proceed with caution when attempting to determine the role of evolutionary age and/or metallicity in the Be phenomenon purely via 2-CD results.

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