Wolf-Rayet spin at low metallicity and its implication for Black Hole formation channels

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The spin of Wolf-Rayet (WR) stars at low metallicity (Z) is most relevant for our understanding of gravitational wave sources such as GW 150914, as well as the incidence of long-duration gamma-ray bursts (GRBs). Two scenarios have been suggested for both phenomena: one of them involves rapid rotation and quasi-chemical homogeneous evolution (CHE), the other invokes classical evolution through mass loss in single and binary systems. WR spin rates might enable us to test these two scenarios. In order to obtain empirical constraints on black hole progenitor spin, we infer wind asymmetries in all 12 known WR stars in the Small Magellanic Cloud (SMC) at Z = 1/5 Zsun, as well as within a significantly enlarged sample of single and binary WR stars in the Large Magellanic Cloud (LMC at Z = 1/2 Zsun), tripling the sample of Vink (2007). This brings the total LMC sample to 39, making it appropriate for comparison to the Galactic sample. We measure WR wind asymmetries with VLT-FORS linear spectropolarimetry. We report the detection of new line effects in the LMC WN star BAT99-43 and the WC star BAT99-70, as well as the famous WR/LBV HD 5980 in the SMC, which might be evolving chemically homogeneously. With the previous reported line effects in the late-type WNL (Ofpe/WN9) objects BAT99-22 and BAT99-33, this brings the total LMC WR sample to 4, i.e. a frequency of ~10%. Perhaps surprisingly, the incidence of line effects amongst low-Z WR stars is not found to be any higher than amongst the Galactic WR sample, challenging the rotationally-induced CHE model. As WR mass loss is likely Z-dependent, our Magellanic Cloud line-effect WR stars may maintain their surface rotation and fulfill the basic conditions for producing long GRBs, both via the classical post-red supergiant (RSG) or luminous blue variable (LBV) channel, as well as resulting from CHE due to physics specific to very massive stars (VMS).

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