Nucleosynthesis in advective accretion disc and outflow: possible explanation for overabundances in winds from X-ray binaries

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Multiple spectroscopic lines of different elements observed in winds from X-ray binaries (XRBs), based on one zone model, indicate super-solar abundance of elements, e.g. Mg, Si, S, Ar, Ca, Cr, Mn, Co. The one zone model considers similar hydrodynamics of underlying winds. In order to find a possible origin of these overabundances, we explore nucleosynthesis in advective, geometrically thick, sub-Keplerian, accretion disc in XRBs and active galactic nuclei (AGNs), and further in outflows launched from the disc. Based on flow hydrodynamics and solving nuclear network code therein by semi-implicit Euler method, we obtain abundance evolution of the elements. Although the density is very low, due to very high temperature of advective disc than Keplerian Shakura-Sunyaev disc (SSD), it is quite evident that significant nucleosynthesis occurs in the former. As the temperature at the base of the outflow is constrained by the temperature of disc, nucleosynthesis also occurs in the outflow contingent upon its launching temperature. Till now, the outer region of XRB and AGN discs is understood to be colder SSD and inner region to be advective disc, together forming a disc-wind system. Hence, newly evolved abundances after processing through outflow can change the abundances of different elements present in the environment of the whole disc-wind system. We find 2-6 times overabundant Mg, Si, Ar, Cr with respect to the respective solar abundances, which is consistent observationally. Thus for most XRBs, when only iron lines are present, inclusion of these evolved abundances is expected to change the observational analysis drastically.

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[1] S.R. Datta & B. Mukhopadhyay, MNRAS **486**, 1641-1651 (2019).