Astrophys Space Sci
DOI 10.1007/s10509-013-1666-0

ORIGINAL ARTICLE

Empirical constraints for the magnitude and composition of galactic winds

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Received: 7 September 2013 / Accepted: 8 October 2013

Abstract Galactic winds are a key physical mechanism for understanding galaxy formation and evolution, yet empirical and theoretical constraints for the character of winds are limited and discrepant. Recent empirical models find that local star-forming galaxies have a deficit of oxygen that scales with galaxy stellar mass. The oxygen deficit provides unique empirical constraints on the magnitude of mass loss, composition of outflowing material and metal reaccretion onto galaxies. We formulate the oxygen deficit constraints so they may be easily implemented into theoretical models of galaxy evolution. We parameterize an effective metal loading factor which combines the uncertainties of metal outflows and metal reaccretion into a single function of galaxy virial velocity. We determine the effective metal loading factor by forward-fitting the oxygen deficit. The effective metal loading factor we derive has important implications for the implementation of mass loss in models of galaxy evolution.

Keywords Galaxies: abundances · Galaxies: ISM · Galaxies: star-formation

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1 Introduction

Galaxy scale winds are fundamental to galaxy evolution. The observed baryon content of galaxies is substantially below the cosmic baryon fraction (Papastergis et al. 2012). To account for this deficit, galaxy formation theories require mechanisms to reduce the efficiency with which galaxies grow (e.g., Springel and Hernquist 2003a). Consequently, strong feedback which is capable of launching galactic scale outflows is central to semi-analytic and hydrodynamical galaxy formation models (e.g., Somerville and Primack 1999; Springel and Hernquist 2003a; Schaye et al. 2010; Davé et al. 2011b; Vogelsberger et al. 2013, plus many others). In simulations, energy and/or momentum injected by massive stars is capable of driving gas out of galaxies. Although these outflows are primarily required to regulate the growth of galaxies, they also drive metals out of the interstellar medium (ISM). Outflows reduce the metal content in galaxies and contribute to the enrichment of the circumgalactic and intergalactic medium (e.g. Springel and

Published online: 26 October 2013