R06b Testing Intermittency of the Galactic Star Formation History along with the Infall Model

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Recent observational data suggest that the star formation history (SFH) of galaxies, especially of spirals and irregulars, is not continuous, but violently and intermittently varies with time. In this study we analyzed the SFH of the Galactic disk by using the infall model of galaxy evolution.

Based on the observed SFH of the Galactic disk provided by Rocha-Pinto et al. (1999), we first determined the timescales of the gas infall into the Galactic disk ($t_{\rm in}$) and that of the gas consumption to form stars ($t_{\rm sf}$). We found that each of the two timescales cannot be determined independently, and thus we derived $t_{\rm in}$ based on χ^2 minimization, under three fixed values of $t_{\rm sf}$. Consequently, we obtained the following parameter sets: ($t_{\rm sf}$ [Gyr], $t_{\rm in}$ [Gyr]) = (4.5, 33), (10.5, 9), and (15, 7.5), where we assumed the Galactic age of 15 Gyr. All of these three cases yield almost identical SFH. We, then, tested the intermittency of the star formation rate (SFR) along with the smooth SFH suggested from the infall model statistically. The χ_0^2 statistic showed that the observed SFH of the Galaxy cannot be produced from a smooth SFH, and the violent temporal variation is strongly supported. Thus we, next, applied the model consists of two components, smooth part and variable part, for the Galactic SFH. The smooth part evolves along with the infall model with the above parameters, and the variable part is defined as the residual of the observed SFH from the infall model. We derived the second-, third-, and fourth-order moments of the frequency distribution of the variable part, and found that the amplitude of the time variation does not distributed as Gaussian, but has a much flatter distribution. This also supports the extremely intermittent picture of the Galactic SFR originally proposed by Rocha-Pinto et al. (1999). Nonlinear oscillation of the interstellar medium or star formation by stochastic infall of small clouds might be possible explanations of the phenomenon.