## 5. Time integration*

The time integration of the model is carried out in the leapfrog scheme with the periodical use of the Euler backward (Matsuno) scheme. To explain the procedure, we write the equation symbolically in the following form ;

$$dA/dt=f(A) \tag{5.1}$$

The leapfrog scheme (L) is

$$(A^{\tau+1}-A^{\tau-1})/2\Delta t=f(A^{\tau}) \tag{5.2}$$

The Matsuno scheme (M) is a combination of the following two steps ;

$$\begin{aligned}&(A^{*\tau+1}-A^{\tau})/\Delta t=f(A^{\tau}) \quad : \text{Euler (foreward)}\\ &(A^{\tau+1}-A^{\tau})/\Delta t=f(A^{*\tau+1}) \quad : \text{Backward}\end{aligned} \tag{5.3}$$

The time integration scheme is schematically shown in Fig. 5.1.

At present, diabatic terms, dissipative terms and the vertical flux convergence terms of both the mixing ratio of water vapor and ozone are calculated in every eight time steps at the Euler (Foreward) stage, as shown by the arrows.

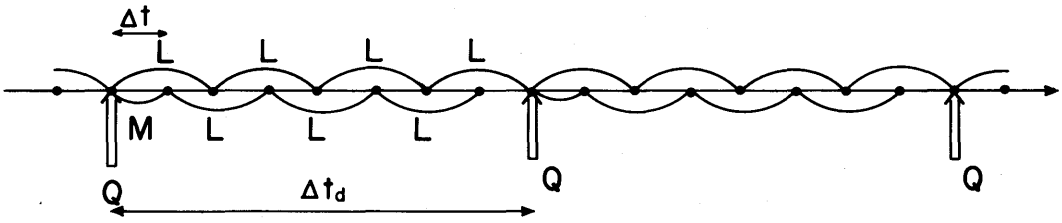


Fig. 5.1 Schematic figure of time integration. M indicates Matsuno step and L, leap-frog step. Time integration of adiabatic part of the model is performed with the time interval Δ t, while diabatic effects Q, including diffusions, are calculated with the time interval $\Delta t_d$.

* This chapter is prepared by T. Tokioka.