CHAPTER 5

Determination of projected rotational velocity

5.1 The Fourier-transformed method

The basic assumption is to interpret a given absorption line profile $D(\lambda)$ as a convolution between an "intrinsic" line profile $F(\lambda)$, this is the line profile that includes atomic data, temperature and element abundance effects, turbulent velocity fields and instrument effects (*Reiners* 2002)[11]. Rotational broadening function $G(\lambda)$ and also include limb darkening. With this assumption $D(\lambda)$ can be written as

$$D(\lambda) = F(\lambda) * G(\lambda)$$
(5.1)

For rotation dominates line profiles, Gray (1976)[6] developed broadening functions inferred from turbulent velocity fields. Fourier transform of the profiles is convenient to an analysis of absorption lines. Equation 5.1 simplifies in Fourier domain to

$$d(\sigma) = f(\sigma) * f(\sigma)$$
(5.2)

where we use the Fourier frequency σ expressed in cycle/(km s-1) and $d(\sigma)$, $f(\sigma)$, and $g(\sigma)$ are the Fourier transforms of $D(\lambda)$, $F(\lambda)$, and $G(\lambda)$, respectively. In the Fourier domain convolutions become multiplications, especially zero positions of $g(\sigma)$ inferred from any broadening remain unchanged by other effect. So the first minimum of the Fourier transform defines the projected rotational velocity $v \sin i = q_1/\sigma_1$, where σ_1 is the value of the first minimum of the Fourier transform and q_1 is a function of the limb-darkening coefficient $q_1 = 0.610 + 0.062\epsilon + 0.027\epsilon^2 + 0.012\epsilon^3 + 0.004\epsilon^4$.

5.2 **Reconstruction of LSD profiles**

To prepare the LSD profiles, a *Period04 program* is used to determine projected rotational velocity which calculated from broadening line profile. The program is arranged to calculate the profile in intensity scale from 0 to 1. In our LSD profiles, the wavelength window of each order were trimmed both ends of each spectrum to have a particular velocity window size (-100 km/s – 100km/s). Then, the window profiles would be inversed in the intensity scale, broadening line profile remaining.

The other thing to prepare LSD profile is, the center of broadening line profiles that are determined should be shifted into a zero scale. To shift each LSD profile, all the coefficients of the differential-correction terms can be calculated from the preliminary estimation of the orbital elements. The (O-C) value or the difference between the observed velocity (O) and the calculated velocity (C) from the initial estimation was performed for the value ΔV at the time of observation t. After that, all the LSD profile would be subtracted by gamma velocity of the system. Hence, the LSD profile were defined in zero velocity scale.



Figure 5.1: Reconstruction of LSD profile by inverse and trimed both end of this spectra.

5.3 Determination of projected rotational velocities

To find the projected rotational velocities, the Fourier transform method of the LSD profile was calculated by *Period04 program* to determine broadening profile into Fourier transform function. The first minimum can be used to calculate projected rotational velocity following

$$v\sin i = q_1/\sigma_1 \tag{5.3}$$

where $q_1 = 0.610 + 0.062\epsilon + 0.027\epsilon^2 + 0.012\epsilon^3 + 0.004\epsilon^4$

The first minimum and the projected rotational velocity are expressed in table 5.1



Figure 5.2: A fourier transformed rotational broadening function $g(\sigma)$ was indicated the first zero minimum.

According to these projected rotational velocity result, these result are expressed approximately 54 km/s. but except some spectrum number, the value are too different. If the total LSD profiles (figure 5.3) according to phase are compared with the table result, the reason would be revealed. There are some different value because the variation of LSD profiles in shape which might be from any phenomenon or any mistake during the observation we cannot confirm yet. So, to calculate mean rotational velocity, the value from the LSD profiles which different with other were excluded. Finally, the projected rotational velocity was accepted at 54.234 km/s.



Phase	Spectrum	First minimum	R_{rot} (km/s)
0.9534	3721036	0.011961	54.109188
0.9467	3721034	0.011901	54.381985
0.9339	3723016	0.012061	53.660559
0.9252	3723014	0.011841	54.657546
0.9050	3351036	0.011699	55.320968
0.8664	3351026	0.012281	52.699292
0.8564	3304072	0.011981	54.018863
0.7751	3668074	0.011881	54.473529
0.7680	3668072	0.011761	55.029334
0.7125	3337028	0.029343	22.056368
0.7104	3744010	0.011941	54.199816
0.7010	3452018	0.012421	52.105306
0.6988	3337024	0.012401	52.18934
0.6845	3452010	0.012061	53.660559
0.6804	3742004	0.012061	53.660559
0.6748	3742002	0.012001	53.928839
0.6709	3660056	0.011781	54.935914
0.6417	3779010	0.013361	48.439488
0.6165	3403029	0.012041	53.749689
0.6121	3405062	0.030823	20.997307
0.5795	3403014	0.028023	23.095315
0.5668	3403008	0.026923	24.038926
0.5325	3689061	0.011801	54.84281
0.5266	3689059	0.011801	54.84281
0.4622	3722029	0.011721	55.217132
0.4541	3722027	0.011801	54.84281
0.3891	3350035	0.012721	50.876503
0.3292	3424022	0.011388	56.831753
0.3100	3305034	0.011381	56.866708
0.2710	3667073	0.011641	55.596598
0.2649	3667071	0.011701	55.311512
0.2610	3457021	0.011561	55.981317
0.2560	3457019	0.011701	55.311512
0.2457	3377015	0.011533	56.117229
0.1816	3663056	0.011741	55.123073
0.1729	3663054	0.011801	54.84281
0.1606	3741004	0.011532	56.122095
0.1546	3741002	0.011538	56.09291
0.1521	3659047	0.012821	50.479682
0.1454	3659045	0.012081	53.571724
0.1315	3406024	0.012161	53.219308

Table 5.1: The first minimum value and projected rotational velocity of EI Eri were calculated from Fourier transform according to phase sequence 1 to 0.

กมยนดิ

The first minimum value and projected rotational velocity of EI Eri were calculated from Fourier transform according to phase sequence 1 to 0 (top to below)(Cont').

6	i / //	1/ 10	31
Phase	Spectrum	First minimum	R_{rot} (km/s)
0.1156	3406018	0.028203	22.947913
0.0864	3404011	0.011821	54.750021
0.0721	3404005	0.011501	56.273368
0.0697	3402018	0.012161	53.219308
0.0518	3692047	0.011961	54.109188
0.0461	3692045	0.012101	53.483183
0.0402	3692043	0.012221	52.958023

<mark>ລິບສີກຣົ່ມหາວີກຍາລັຍເຮີຍວໃหມ່</mark> Copyright[©] by Chiang Mai University AII rights reserved