PHOTOMETRIC AND POLARIMETRIC STUDIES OF ECLIPSING BINARIES

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We present photometric observations of seven eclipsing binary stars and their O-C curve analysis to investigate their orbital period variations. For IV Dra, KM UMa and V343 UMa, we present first B, V, R and I bands observations. The present light curves of the sample stars have complete phase coverage. The O-C curve of FO Hya, IV Dra, KM UMa and V343 UMa are also presented for the first time in our work. The O-C analysis of FO Hya, FZ Ori, LP UMa and IV Dra, indicate an increase in its orbital period. However, the orbital period of KM UMa is found to decrease. The secular variation in the orbital period may be caused by the mass transfer between components. The orbital period of FO Hya, FZ Ori and KM UMa have varied in a combination with the parabolic and sinusoidal variation. The sinusoidal variation can be interpreted as the LITE effect due to the existence of a tertiary companion. Because of the absence of any independent tertiary companion detection, we consider the possibility that a magnetic activity cycle may be the main cause of the sinusoidal period variation. Parameters of the tertiary companion are also obtained along with those of the sample binaries. We present modeling of the light curves and results of our sample stars. The modeling of the light curves of FO Hya, FZ Ori, LP UMa and KM UMa indicate the need of a third light as suggested by their O-C analysis with long term databases including our present observations. The geometrical and physical parameters of our sample stars namely IV Dra, KM UMa and V343 UMa are presented for the first time.

Also, we present first polarimetric study of FO Hya, FZ Ori and V407 Peg. The study shows that light coming from stars may be polarised mostly due to scattering of light in a gaseous envelope of the FO Hya, FZ Ori and V407 Peg binary systems. This can be observed in the integrated light of the binary system. The Stokes' parameters of the FZ Ori and V407 Peg appear to be orbital phase dependent. We estimated the masses of gas streams and the mass loss rates for FO Hya, FZ Ori and V407 Peg. The mass loss rate derived from polarimetric observations has found to be in good agreement with the photometric results.The orientation of the orbital plane of the FO Hya, FZ Ori and V407 Peg in space is estimated from position angle of the intrinsic polarization.

Power spectra

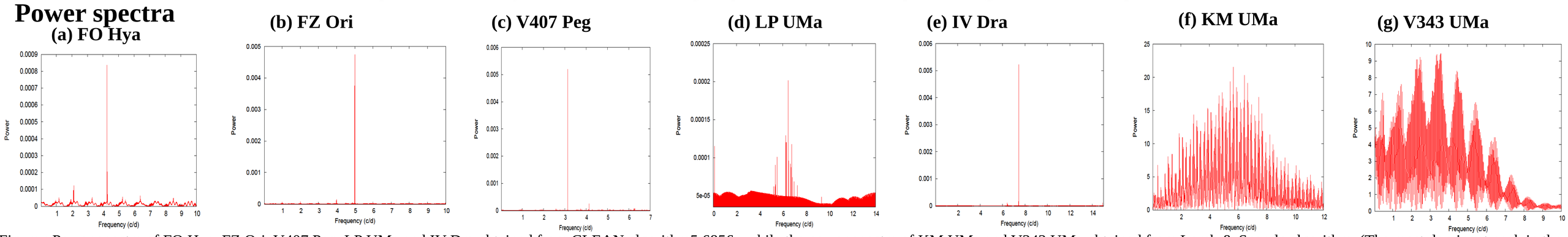


Figure : Power spectra of FO Hya, FZ Ori, V407 Peg, LP UMa and IV Dra obtained from CLEAN algorithm5.6856 , while the power spectra of KM UMa and V343 UMa obtained from Lomb & Scargle algorithm (The most dominant peak in the spectra occurs to ~ 4.2592 (day⁻1), ~ 5.0 (day⁻1), ~ 3.1404 (day⁻1), ~ 6.45386 (day⁻1), ~ 7.45987 (day⁻1), ~ (day⁻1) and ~ 3.5691 (day⁻1) for FO Hya, FZ Ori, V407 Peg, LP UMa, IV Dra, KM UMa and V343 UMa, respectively.)

O-C analysis

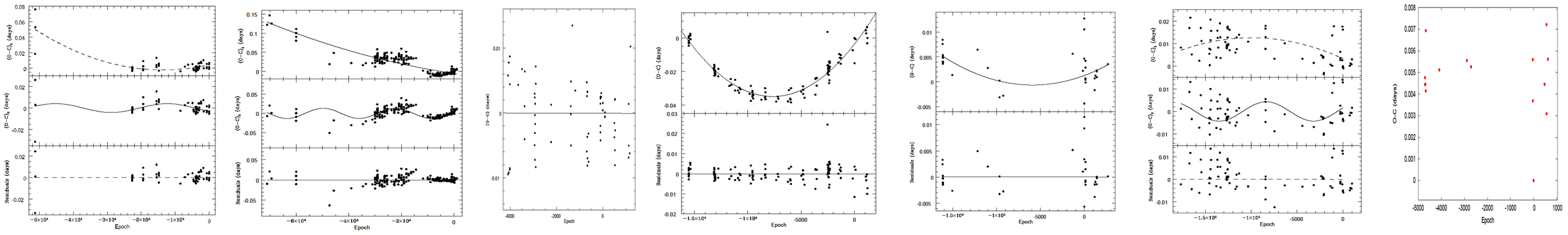
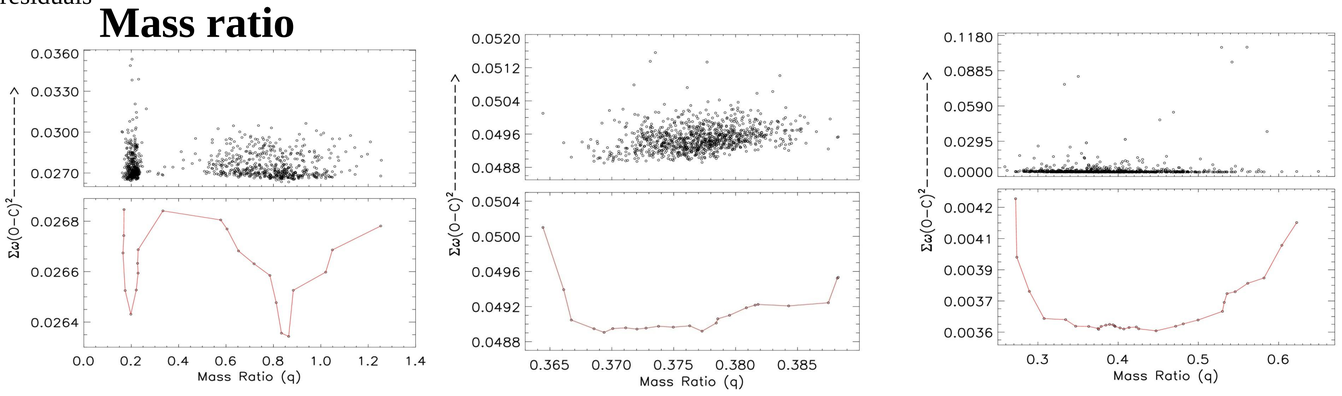


Figure: The top panel: $(O-C)_1$ diagram computed using ephemeris of FO Hya, FZ Ori, V407 Peg, LP UMa, IV Dra, KM UMa and V343 UMa, respectively (The general trend of the $(O-C)_1$ curve reveals a long-term period increase, while the trend of the (O-C) isvalues not changing significantly for V407 Peg and V343 UMa). The middle panel: the $(O-C)_2$ curve from the parabolic fit and its description by a sinusoidal equation (solid line) FO Hya, FZ Ori, KM UMa. The bottom panel: residuals

Mass ratio



Inclination

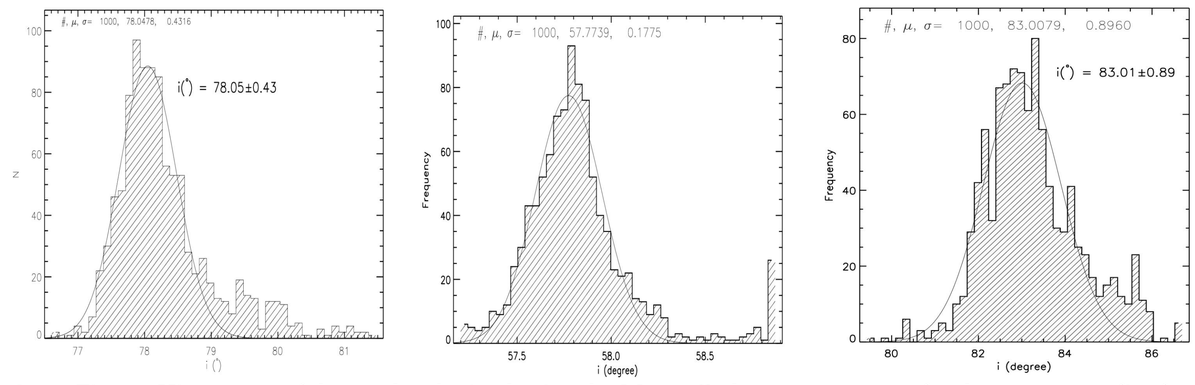


Figure: The upper panel is plot of the sum of weighted-square deviations, $\Sigma\omega_i(O-C)^2$ versus mass ratio, q of FZ Ori, KM UMa and V343 UMa for several iterations (The minimum of sum of weighted-square deviations and their corresponding mass ratio values from upper panel are plotted in lower panel for checking variation of q with $\Sigma\omega_i(O-C)^2$ for small range. The minimum of $\Sigma\omega_i(O-C)^2$ occurs at q = 0.860, 0.369 and 0.450 for FZ Ori, KM UMa and V343 UMa respectively.

Figure: Histograms of the results obtained using the Monte Carlo parameter scan for the parameters fit of inclination in the contact mode for FO Hya, FZ Ori and in the near-contact mode for KM UMa with PHOEBE

Modeling of the light curves

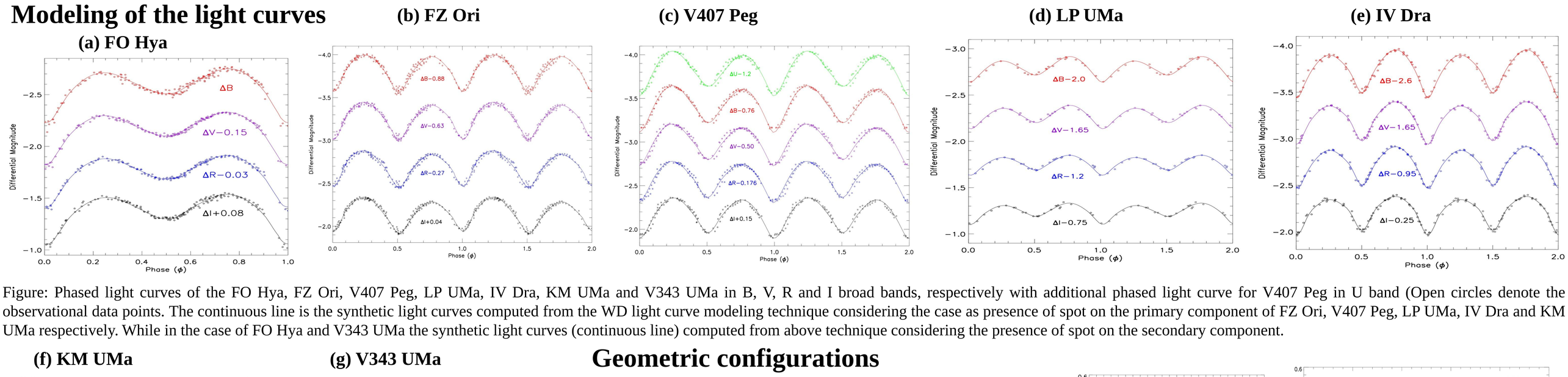


Figure: Phased light curves of the FO Hya, FZ Ori, V407 Peg, LP UMa, IV Dra, KM UMa and V343 UMa in B, V, R and I broad bands, respectively with additional phased light curve for V407 Peg in U band (Open circles denote the observational data points. The continuous line is the synthetic light curves computed from the WD light curve modeling technique considering the case as presence of spot on the primary component of FZ Ori, V407 Peg, LP UMa, IV Dra and KM UMa respectively. While in the case of FO Hya and V343 UMa the synthetic light curves (continuous line) computed from above technique considering the presence of spot on the secondary component.

Geometric configurations

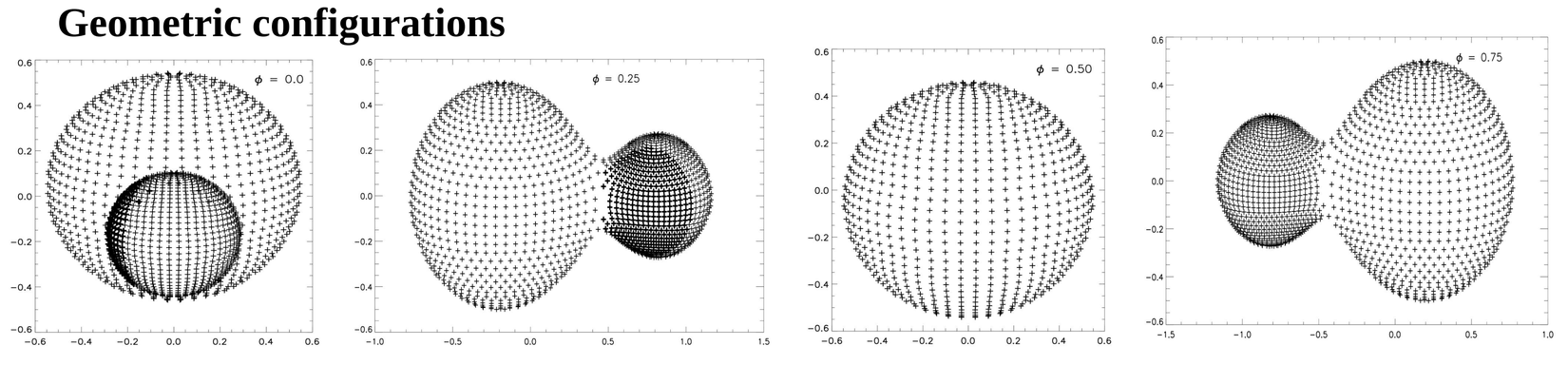
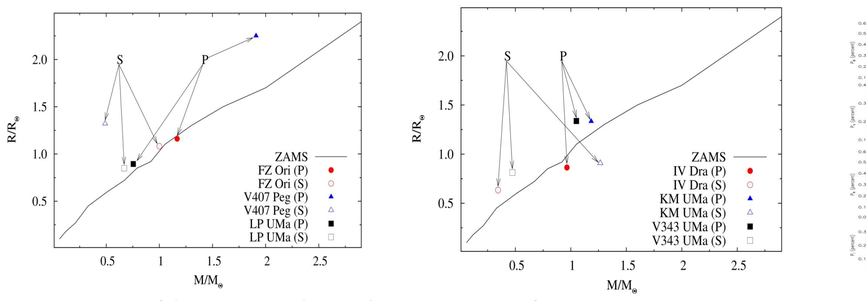
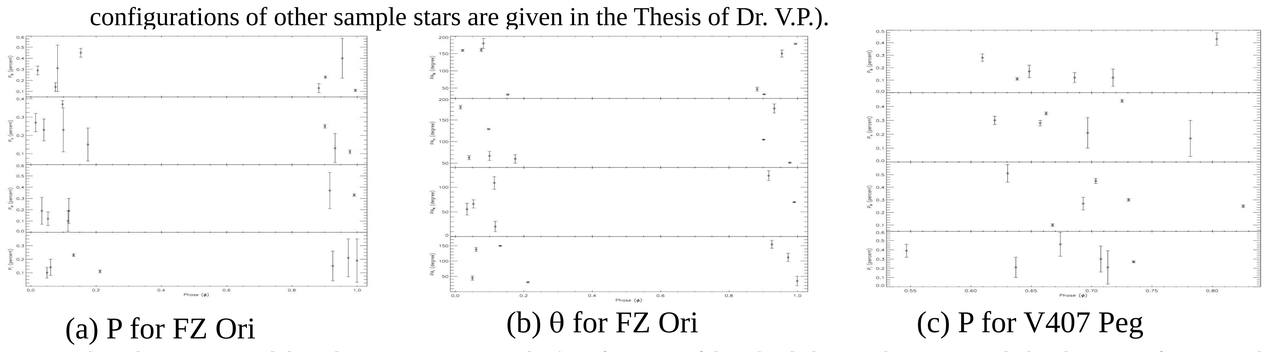


Figure: Geometric configurations of FO Hya generated by PHOEBE at phases (Φ) = 0.00, 0.25, 0.50 and 0.75, respectively (The geometric configurations of other sample stars are given in the Thesis of Dr. V.P.).



(a) (b)

Figure: Location of the primary and secondary components of FZ Ori,V407 Peg, LP UMa, IV Dra, KM UMa and V343 UMa on mass-radius diagram (The continuous line shows the zero age main sequence. The symbols circle, triangle and square of Fig. (a) represent FZ Ori, V407 Peg and LP UMa systems, respectively. While, the symbols circle, triangle and square of Fig. (b) represent IV Dra, KM UMa and V343 UMa systems, respectively.)



(a) P for FZ Ori (b) θ for FZ Ori (c) P for V407 Peg (d) θ for V407 Peg

Figure: The polarization, P and the polarization position angle, θ, as functions of the orbital phase in the B, V, R and I bands running from top to bottom for [(a)and (b)] FZ Ori, and [(c) and (d)] V407 Peg

References: 1. Prasad, V., 2014, Ph.D. Thesis. 2. Prasad et al. 2013, 2014

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