

## Echelle Spectrum Analysis Package - TIGER

Timur ŞAHİN<sup>1</sup>

<sup>1</sup> Akdeniz Üniversitesi, Fen Fakültesi, Uzay Bilimleri ve Teknolojileri Bölümü, 07058, Antalya  
(eposta: timursahin@akdeniz.edu.tr)

**Abstract:** In this study, an echelle spectrum reduction package in IDL, TIGER, is presented.

### 1. Introduction

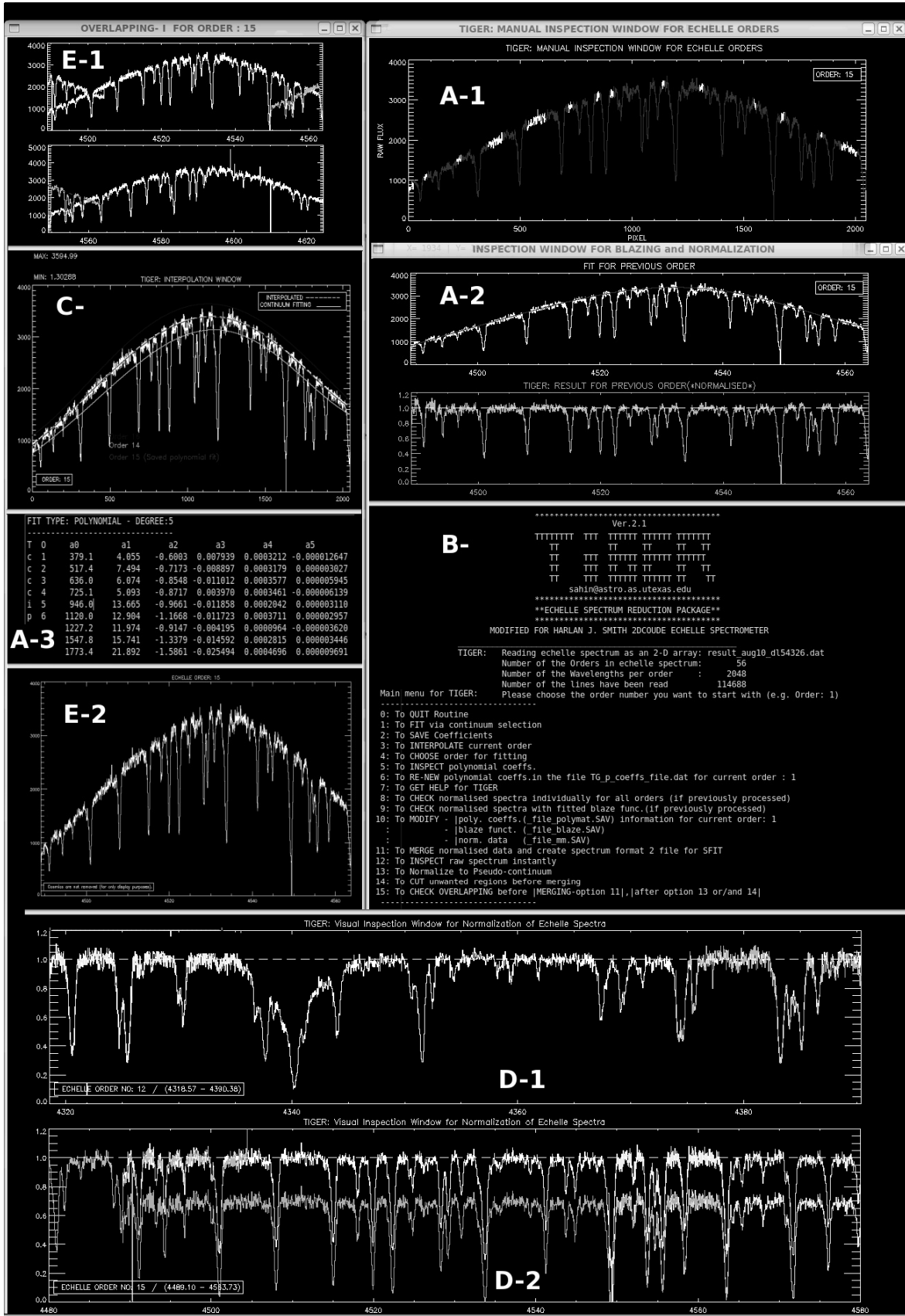
The difficulty in combining many spectral orders of an echelle spectrum to produce a single continuous spectrum arises because the blaze function varies rapidly along each order so normalization of the spectrum may not be possible by processing the spectrum as a whole although there have been studies of large scale blaze function correction (Katz et al. 1998). Under such circumstances where a large scale blaze function correction is not applicable, a flat image or a spectrum of a similar temperature and similar reddening metal-poor star with as few lines as possible (e.g. a white dwarf or sub dwarf) can be used for normalization. Indeed, a flat-field calibration lamp may define the blaze function but, in practice, it is not easy. There are some optical components in the flat-field beam which may create some residuals when applied to astrophysical observations so that using spectra of astrophysical sources instead of flat-field images may provide an alternative solution to this problem.

Removal of blaze function can also be performed on an order by order basis.

In this study, I report an echelle spectrum analysis package that I call, TIGER (Şahin 2008), an in-house IDL package (see B- in Figure 1.), consists of several methods for normalization of echelle spectra.

### 2. Capabilities of TIGER

- Spectral order fitting (see A-2 in Figure 1.).
- Interpolation of blaze profiles (see C- in Figure 1.).
- Normalization via continuum selection (see A-1 and -2 in Figure 1.).
- Pseudo-continuum normalization.
- Cosmic-ray removal.
- Quick-look fitting and overlapping inspection (see E-1 and -2 in Figure 1.).
- Manipulation of rectified orders interactively prior to merging.
- Merging of rectified spectral orders.
- Quick-look spectrum inspection.
- Production of merged and rectified spectrum in spectrum-2(SP2) file format.



### 3. Spectral order fitting

In TIGER, order fitting can be performed via polynomials interactively. The normalized result is shown just after the selection for inspection purposes. The user is able to exclude unwanted regions such as absorption / emission lines, spikes etc. From spectral orders interactively (see A-1 and -2 in Figure 1.). This process can be repeated for the best fit to the spectrum.

In section A-3 of the Figure 1., I present 5<sup>th</sup> order polynomial fitting coefficients for 9 adjacent orders for a post-AGB star. It also shows the example fitting database created in the code, TIGER. The p and c abbreviations in the first column stand for normalization with interactive (c)ontinuum-selection and (p)seudo-continuum normalization respectively. TIGER allows this information to be updated when needed.

### 4. Interpolation of blaze profiles

For some echelle orders, continuum fitting may not give the best result. This can be due to an inappropriate dekker determination, or to diffuse light in the spectrograph, a common difficulty with echelle spectra, or to wide absorption features (e.g. Balmer or Paschen Hydrogen lines) in the spectrum. Interpolation of the blaze functions from adjacent orders can be a solution, and TIGER makes this possible (see C- in Figure 1.).

### 5. Pseudo-continuum normalization

If spectral order fitting via interactive mouse selection or interpolation of successive orders is not a solution for the spectra, users are advised to use pseudo-continuum normalization option in TIGER. When this routine is run, overlapping regions in adjacent echelle orders are determined, and displayed on the screen (see D-1 and -2 in Figure 1.).

### 6. Evaluation of the code

TIGER has been extensively used in the literature. A few of my recent works which make use of TIGER are as follows: Şahin et al.(2012); Naslim et al.(2011); Şahin et al.(2011); Naslim et al.(2010); Naslim et al.(2010); Şahin & Lambert(2009); Ahmad et al.(2007).

### 7. Future work

The code is planned to be embedded in a GUI interface to be publicly available.

### 8. References

- Ahmad, A., Behara, N.~T., Jeffery, C.~S., Sahin, T., & Woolf, V.~M. 2007, A&A, 465, 541  
Katz, D., Soubiran, C., Cayrel, R., Adda, M., & Cautain, R. 1998, A&A, 338, 151  
Naslim, N., Jeffery, C.~S., Behara, N.~T., & Hibbert, A. 2011, MNRAS, 412, 363  
Naslim, N., Jeffery, C.~S., Ahmad, A., Behara, N.~T., & Şahin, T. 2010, MNRAS, 409, 582  
Naslim, N., Jeffery, C.~S., Ahmad, A., Behara, N., & Şahin, T. 2010, ApSS, 329, 119  
Şahin, T., Lambert, D.~L., & Allende Prieto, C. 2012, arXiv:1203.1461  
Şahin, T., Lambert, D.~L., Klochkova, V.~G., & Tavganskaya, N.~S. 2011, MNRAS, 410, 612  
Şahin, T., & Lambert, D.~L. 2009, MNRAS, 398, 1730  
Şahin, T., 2008, Ph.D.~Thesis, Queen's University Belfast, UK

