1 Introduction

The improvement of the wavelength scale of the RGS instruments has been one of the prime objectives of the XMM-Newton calibration since the beginning the mission.

The accuracy of the wavelength scale of a given RGS spectrum depends on one side on the knowledge of all the parameters involved in the geometry of the system (given in the calibration files) and on the other, on the precision of the coordinates of the considered source, that are needed by SAS to process the data.

Previous studies of RGS spectra of emission line sources have shown that there is a systematic shift of the line positions with respect to laboratory wavelengths, and that the wavelength scales of both RGS are displaced by a few mÅ. These works have also established that wavelengths measured in RGS spectra are accurate to \( \approx 7 \) mÅ in first order and to \( \approx 5 \) mÅ in second order (Lorente et al. 2003).

Along the last years, several studies have been carried out to clarify the origin of these systematic effects and to identify possible ways to minimise them.

Coia and Pollock (2007, hereafter CP07) measured global fits of 66 observations of the four wavelength calibrators (AB Dor, Capella, Procyon and HR 1099). Special care was put in using accurate coordinates, taking into account the proper motion of the stars. They found a systematic shift of 5 mÅ between first order RGS1 and RGS2 spectra. The shift in second order was smaller, only 2 mÅ. A further study by the same authors (Coia and Pollock, 2008) showed that this systematic shift can be suppressed by changing the incidence angle \( \alpha_0 \) by 1.2 and 3.4 arcsec for RGS1 and RGS2, respectively.

González-Riestra (2008, hereafter GR08) tried to find a correlation between the wavelength shift and other parameter (time, position angle...). This work used a sub-sample of CP07 data (38 observations), and confirmed the shifts previously found, as well as the tight correlation between the shifts of both instruments. The main result of this work was the correlation found between the wavelength shift and the the spacecraft “Solar Angle”\(^1\) (the angular distance between the Sun and the pointing direction, see clarification below).

The application of this correction, in addition to make the average shifts close to zero and to align both instruments, decreases the scatter of the line shifts by \( \approx 20\% \).

This study left some points open. The present report has the following goals:

- To investigate the effect of correcting the observed wavelengths for the velocity of the Earth with respect to the Solar System barycentre,
- To determine if that correction improves the correlation between line shifts and Solar Angle.
- To study the possible dependence of line shifts on wavelength.

To address these points it is necessary to know not only the global shift of each spectrum, but the positions of the individual lines. Therefore the dataset of CP07 is not suitable for this purpose, and a different approach is needed. Also, recent data have been added to the sample.

\(^1\)The relation between wavelength shift and Solar Angle has been confirmed independently by Kaastra et al. (2011) in their analysis of RGS spectra of Mkn 509.
2 Methodology

The new sample is composed of 119 exposures (59 for RGS1, 60 for RGS2) of the four wavelength calibrators (AB Dor, Capella, HR 1099 and Procyon) observed between rev. 54 (March 2000) and 2027 (Jan 2011). The list of spectra used in this work is given in Table 6.

The observations used in the analysis were selected with the following criteria:

- Prime instrument: RGS1
- Maximum offset of the target from the on-axis position: 60 arcsec
- Minimum number of counts in the spectrum: 3000 in first order

All the data where processed with SAS using coordinates corrected for proper motion.

The following lines were considered, with the laboratory wavelengths taken from the CHIANTI database:

- \( \text{Mg XII} \ 8.419 \ \text{Å} \)
- \( \text{Ne X} \ 12.132 \ \text{Å} \)
- \( \text{Fe XVII} \ 15.015 \ \text{Å} \)
- \( \text{Fe XVII} \ 16.777 \ \text{Å} \)
- \( \text{O VII} \ 22.101 \ \text{Å} \)
- \( \text{Fe XVII} \ 16.777 \ \text{Å} \)
- \( \text{N VII} \ 24.779 \ \text{Å} \)
- \( \text{O VIII} \ 18.967 \ \text{Å} \)
- \( \text{C VI} \ 33.734 \ \text{Å} \)

Lines were measured on the fluxed spectra computed with a wavelength bin of 10 mÅ. No specific shape of LSF was used. The line profile was assumed to be composed of a gaussian plus a Lorentzian. The only constraints imposed on the fit were that both components should have the same central wavelength, and that the widths are within some reasonable limits. The relative intensity of both components was left free. Fits were made using the IDL Library MPFIT, taking into account the errors in the data points as derived by the SAS task rgsfluxer. Only measurements with an error of less than 5 mÅ in the line position were used in the analysis.

Note that the values in the CP07 dataset did not include the errors in the measurements, and they were - arbitrarily - assumed in GR08 to be proportional to the number of counts in the spectrum. The errors computed here are more realistic and reliable.

Two corrections were applied to the line positions:

- The velocity of the Earth with respect to the barycentre of the Solar System, projected in the direction of the target. These correction is listed in Table 6. Due to its ecliptic coordinates, this correction is negligible for AB Dor, while for the three other stars it can go up to \( \pm 29 \ \text{km s}^{-1} \), that represents \( \approx 3 \ \text{mÅ} \) in the C VI line.
- The radial velocity of the object\(^2\):
  - Capella: 29 km s\(^{-1}\) (Ishibashi et al. 2006)
  - AB Dor: 30 km s\(^{-1}\) (Nordstroem et al. 2004)
  - HR 1099: -15 km s\(^{-1}\) (Nordstroem et al. 2004)
  - Procyon: -4 km s\(^{-1}\) (Nordstroem et al. 2004)

No corrections have been made:

- For the velocity of the spacecraft in its orbit (not more than 3 km s\(^{-1}\)).
- For the velocities of the emitting star in the binary systems Capella and HR 1099 and for the possible rotational modulation in AB Dor:
  - Ishibashi et al. (2006) in their analysis of Chandra/HETGS data, show that in the case of Capella the lines seem to come from the primary star, and then they follow its radial velocity, that has an amplitude of approximately 40 km s\(^{-1}\), and a period of 104 days. Nevertheless, these authors point out that there could also exist a variable contribution from the secondary star in the higher temperature lines that may cause a shift in the line centroid.

\(^2\)In the first version of this report, slightly different radial velocities were used, within \( \pm 2 \ \text{km s}^{-1} \) of the values listed here, except for HR 1099, where the value previously used was -23 km s\(^{-1}\). This difference in the radial velocities does not change substantially the results.
Table 1: Comparison of average shifts with previous results

<table>
<thead>
<tr>
<th></th>
<th>Line shift (mA)</th>
<th>RGS 1-RGS 2 (mA)</th>
<th>Order 1-Order 2 (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RGS1 o1 RGS2 o1</td>
<td>RGS1 o2 RGS2 o2</td>
<td>Order 1 Order 2</td>
</tr>
<tr>
<td>GR08</td>
<td>6±8</td>
<td>11±9</td>
<td>2±6 5±7</td>
</tr>
<tr>
<td></td>
<td>-5±2</td>
<td>-2±3</td>
<td>2±6 5±7</td>
</tr>
<tr>
<td>GR12</td>
<td>5±7</td>
<td>10±7</td>
<td>4±4 5±4</td>
</tr>
<tr>
<td></td>
<td>-4±2</td>
<td>-1±1</td>
<td>2±4 5±4</td>
</tr>
<tr>
<td>GR12v</td>
<td>3±6</td>
<td>8±7</td>
<td>3±4 4±4</td>
</tr>
<tr>
<td></td>
<td>-5±2</td>
<td>-1±1</td>
<td>2±4 4±4</td>
</tr>
</tbody>
</table>

GR08: Data from CP07.
GR12: This work without velocity corrections.
GR12v: This work, with object and barycentre velocity correction.
errors are standard deviations.

- The Lyman $\alpha$ Ne X line in HR 1099 appears to come from the subdwarf star (Ayres et al. 2001). The orbital period of the system is 2.84 days. The average exposure time of the HR 1099 spectra in the sample is 0.4 days, 13% of the orbital period, and then the position of the lines can change substantially during an observation.

- In AB Dor, rotationally modulated shifts of the order of 30 km $s^{-1}$ have been observed in the O VIII line (Hussain et al. 2005). The rotation period of the star is 0.5 day, of the order of the average exposure time of these data (0.43 days).

These velocities could cause a shift in the line positions of at most $\approx \pm 3$ mA at 20 Å.

For comparison with previous works, an average shift was computed for each spectrum as the weighted average of the individual line shifts, weighted by their errors.

3 Results

3.1 Average Shifts

The average shifts per spectrum, with and without correction for star and barycentre velocities, are shown in Tables 7, 8, 9 and 10 and Fig. 6, 7, 8 and 9, together with the data of CP07, for comparison.

Table 1 shows the average shifts per instrument and spectral order computed in this work compared to those given in GR08. Discrepancies can be explained by the different data samples used.

- We have first compared GR08 results with the values derived here without applying any velocity correction. The new average shifts agree with those derived in GR08 within 2 mA. It must be noted that the rms of the newly derived values is 2 mA smaller, though the sample is larger (60 vs. 38 observations).

- The application of the velocity corrections decreases systematically the average shifts by 2 mA, independently of the instrument and the order.

- The shift between both orders and both instruments does not change (see Fig. 1).

3.2 Correlation of line shifts with Solar Angle

In GR08, line shifts were correlated with the angular distance between the target and the Sun. In what follows we shall refer to this parameter as “Solar Angle” (SA$^3$).

Results of the fit of average shifts with Solar Angle are shown in Table 2 and Fig. 2. The data errors used in the fit are the errors of the mean of the line shifts in each spectrum.

The application of the SA correction removes naturally the systematic shift between instruments and orders.

3This angle is equivalent to the Fine Sun Sensor Pitch Angle + 90 degrees. In GR08 this angle was called “Solar Aspect Angle” (SAA), though, rigorously, the SAA and the SA only coincide for a Roll angle of 0 (as it happens in most of the cases).
Figure 1: Shifts between both instruments and both orders for different datasets (see text for details). Left: Shift between RGS1 and RGS2. Right: Shift between first and second order. Numbers given in the plots are the median and the standard deviation of the distributions.

Table 2: Fits to Solar Angle

<table>
<thead>
<tr>
<th></th>
<th>GR08</th>
<th></th>
<th>GR12</th>
<th></th>
<th>GR12v</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>b</td>
<td>Res</td>
<td>a</td>
<td>b</td>
<td>Res</td>
</tr>
<tr>
<td>RGS1 o1</td>
<td>2.3±0.3</td>
<td>-0.62±0.03</td>
<td>-1±6</td>
<td>3.7±0.2</td>
<td>-0.54±0.02</td>
<td>0±5</td>
</tr>
<tr>
<td>RGS2 o1</td>
<td>7.3±0.3</td>
<td>-0.66±0.03</td>
<td>-2±7</td>
<td>8.3±0.2</td>
<td>-0.56±0.02</td>
<td>0±5</td>
</tr>
<tr>
<td>RGS1 o2</td>
<td>2.3±0.8</td>
<td>-0.32±0.06</td>
<td>0±6</td>
<td>3.7±0.2</td>
<td>-0.31±0.03</td>
<td>-1±3</td>
</tr>
<tr>
<td>RGS2 o2</td>
<td>3.4±0.8</td>
<td>-0.36±0.06</td>
<td>0±6</td>
<td>4.2±0.1</td>
<td>-0.33±0.01</td>
<td>0±3</td>
</tr>
<tr>
<td></td>
<td>1.9±0.2</td>
<td>-0.37±0.02</td>
<td>0±5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.8±0.2</td>
<td>-0.57±0.02</td>
<td>1±5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.4±0.1</td>
<td>-0.30±0.02</td>
<td>1±3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.8±0.1</td>
<td>-0.32±0.02</td>
<td>1±3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

line shift (mÅ) = a + b x (SA - 90)
Res: residuals of the fit in mÅ, errors are standard deviations.

GR08: Data from CP07.
GR12: This work without velocity corrections.
GR12v: This work, with star+barycentre velocity correction.
The slope of the fits, that in GR08 were rather different for RGS1 and RGS2 in first order (-0.62 vs. -0.66 for first order, -0.32 vs. -0.36 for second order) agree better when the new measurements are used. The rms of the residuals of the fit decreases by $\approx 2$ mA with respect to GR08.

A summary of the results is presented in Table 3. After correction for star and barycentric velocities, and application the Solar Angle correction, the rms of the average shifts is substantially reduced with respect to the values obtained in GR08, from 8 to 5 mA in first order, and from 6 to 3 mA in second order (see Fig. 4).

The Sun Angle correction has been applied to the individual lines, and re-computed the line shifts. Histograms of the line shifts are shown in Fig. 5, where the original shifts are shown in black, and the new ones (corrected for stellar and barycentric velocities and after application of the Sun Angle correction) in red.

### 3.3 Correlation of line shifts with wavelength

We have performed a study similar to what has been described in the previous section, but on an individual line basis. We report here only the results obtained after correcting the line positions for star and barycentre velocities.

There seems to exist a trend of the shift being systematically smaller at longer wavelengths (see Table 4 and Fig. 3), but it is not statistically significant. More evident is the trend of the slope of the linear relation with SA being steeper at longer wavelengths. The slope for the C VI line is significantly more negative than for the other lines (Table 5). This effect needs to be further investigated.
Table 3: Summary

<table>
<thead>
<tr>
<th></th>
<th>GR08</th>
<th>GR08s</th>
<th>GR12</th>
<th>GR12v</th>
<th>GR12vs</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGS1 o1</td>
<td>6±8</td>
<td>-1±6</td>
<td>5±7</td>
<td>3±6</td>
<td>1±5</td>
</tr>
<tr>
<td>RGS2 o1</td>
<td>11±9</td>
<td>-2±7</td>
<td>10±7</td>
<td>8±7</td>
<td>1±5</td>
</tr>
<tr>
<td>RGS1 o2</td>
<td>2±6</td>
<td>0±6</td>
<td>4±4</td>
<td>3±4</td>
<td>1±3</td>
</tr>
<tr>
<td>RGS2 o2</td>
<td>5±7</td>
<td>0±6</td>
<td>5±4</td>
<td>4±4</td>
<td>1±3</td>
</tr>
</tbody>
</table>

Line shifts in mA, errors are standard deviations.

GR08: Data from CP07
GR08s: Data from CP07, with Solar Angle correction.
GR12: This work without velocity corrections.
GR12v: This work with system and barycentre velocity correction.
GR12vs: This work with star+barycentre velocity and Solar Angle correction.

Table 4: Shifts of individual lines

<table>
<thead>
<tr>
<th>Line</th>
<th>RGS1 o1</th>
<th>RGS2 o1</th>
<th>RGS1 o2</th>
<th>RGS2 o2</th>
<th>Order 1</th>
<th>Order 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.419</td>
<td>3±8</td>
<td>8±8</td>
<td>-1±6</td>
<td>-3±6</td>
<td>-5±6</td>
<td>-1±5</td>
</tr>
<tr>
<td>12.134</td>
<td>4±2</td>
<td>9±7</td>
<td>3±4</td>
<td>4±4</td>
<td>...</td>
<td>-1±2</td>
</tr>
<tr>
<td>15.015</td>
<td>3±7</td>
<td>10±7</td>
<td>1±5</td>
<td>4±4</td>
<td>-7±3</td>
<td>-2±4</td>
</tr>
<tr>
<td>16.777</td>
<td>3±7</td>
<td>5±7</td>
<td>1±5</td>
<td>1±5</td>
<td>-1±4</td>
<td>-2±4</td>
</tr>
<tr>
<td>18.969</td>
<td>4±7</td>
<td>8±6</td>
<td>1±4</td>
<td>...</td>
<td>-4±3</td>
<td>...</td>
</tr>
<tr>
<td>21.602</td>
<td>1±7</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>22.101</td>
<td>-1±7</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>24.781</td>
<td>...</td>
<td>8±8</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>33.736</td>
<td>0±9</td>
<td>4±10</td>
<td>...</td>
<td>...</td>
<td>-6±6</td>
<td>...</td>
</tr>
</tbody>
</table>

Avg: from Table 1, shown for comparison.

Avg: from Table 1, shown for comparison.

Figure 3: Comparison of the shifts of two lines at different wavelengths: C VI 33.73 Å (black) Fe XVII 15.01 Å (red). Numbers given in the plots are the median and the standard deviation of the distributions.
## Table 5: Fit of shifts of individual lines with Solar Angle

<table>
<thead>
<tr>
<th></th>
<th>RGS1 o1</th>
<th>RGS2 o1</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>b</td>
<td>Res (mA)</td>
</tr>
<tr>
<td>8.419</td>
<td>-0.7±0.7</td>
<td>-0.51±0.05</td>
</tr>
<tr>
<td>12.134</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>15.015</td>
<td>4.0±0.2</td>
<td>-0.37±0.01</td>
</tr>
<tr>
<td>16.777</td>
<td>4.1±0.2</td>
<td>-0.53±0.01</td>
</tr>
<tr>
<td>18.969</td>
<td>3.6±0.1</td>
<td>-0.56±0.01</td>
</tr>
<tr>
<td>21.602</td>
<td>2.2±0.2</td>
<td>-0.56±0.02</td>
</tr>
<tr>
<td>22.101</td>
<td>-0.7±0.3</td>
<td>-0.56±0.02</td>
</tr>
<tr>
<td>24.781</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>33.736</td>
<td>-0.7±0.4</td>
<td>-0.63±0.04</td>
</tr>
<tr>
<td>Avg</td>
<td>1.9±0.2</td>
<td>-0.57±0.02</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>RGS1 o2</th>
<th>RGS2 o2</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>b</td>
<td>Res (mA)</td>
</tr>
<tr>
<td>8.419</td>
<td>-4.2±0.8</td>
<td>-0.32±0.06</td>
</tr>
<tr>
<td>12.134</td>
<td>2.7±0.2</td>
<td>-0.29±0.02</td>
</tr>
<tr>
<td>15.015</td>
<td>1.8±0.2</td>
<td>-0.30±0.01</td>
</tr>
<tr>
<td>16.777</td>
<td>-1.8±0.6</td>
<td>-0.28±0.05</td>
</tr>
<tr>
<td>18.969</td>
<td>1.3±0.2</td>
<td>-0.29±0.02</td>
</tr>
<tr>
<td>Avg</td>
<td>1.4±0.1</td>
<td>-0.30±0.02</td>
</tr>
</tbody>
</table>

line shift (mA) = a + b x (SA - 90)
Avg: from Table 1, shown for comparison.
Res: residuals of the fit in mA, errors are standard deviations.

## 4 Conclusions

We have shown that the accuracy of the RGS wavelength scale, derived using a dataset of observations with precise coordinates and corrected for Earth and stellar velocities, is 6 and 4 mA, for first and second order spectra, respectively (from measurement of individual lines; the accuracy derived from average shifts is 5 and 3 mA). Both spectrographs show a systematic offset with respect to laboratory wavelengths, that is larger for RGS2.

It must be noted that these values have been obtained from a well controlled dataset, to which several corrections were applied. Wavelengths measured on spectra to which no (or different) corrections are applied would be less accurate.

Using this improved dataset, we have derived new values of the parameters of the “Solar Angle” correction (i.e. the dependence of the line shift with the angular distance between the target and the Sun). The error in the slope of the linear fit decreases with respect to previous values, for first order data from 0.03 to 0.02, and from 0.06 to 0.02 in second order. The application of this correction allows to align both instruments and both spectral orders, and decreases the scatter in the average shifts to 5 and 3 mA for first and second order spectra, respectively.

We have also studied a possible dependence of the line shifts on wavelength (i.e. different lines having different shifts), but we have not found a clear correlation. There are some indications of the shift of the C VI line being systematically smaller than for e.g. Fe XVII. The slope of the relation with SA is definitely steeper for the C VI line. More work needs to be made in this respect. Until this study is done, the application of the SA relation derived from the average spectrum shifts would represent already a significant improvement in the RGS wavelength scale.

The conclusions of this report are as follows:

- The accuracy of the RGS wavelength scale can be improved through the application of several corrections.
- Some of them cannot be generally applied to all observations, in particular in the context of Pipeline processing. This is the case of a proper assessment of the object coordinates (e.g. effects
Figure 4: Comparison of the average spectrum shifts before (black) and after (red) applying velocity and Solar Angle corrections. Numbers given in the plots are the median and the standard deviation of the distributions.

Figure 5: Comparison of the individual line shifts before (black) and after (red) applying velocity and the average Solar Angle corrections. Numbers given in the plots are the median and the standard deviation of the distributions.
of proper motion, the case of extended objects), that can nevertheless be applied by the user re-processing the data with SAS. In case accurate wavelengths are needed, a correction for the radial velocity of the studied object must be applied as well, but this should be left to the user during the analysis of the data.

- On the other hand, some important corrections can be easily implemented within SAS:
  
  - The wavelength scale should be referred to the barycenter of the Solar System. Therefore, a barycentric correction has to be applied to the observed wavelengths. This correction is the velocity of the Earth with respect to the barycentre of the Solar System projected in the direction of the target, that depends only on the date of the observation and the coordinates of the object. It can amount up to $\approx \pm 2 \text{ mÅ}$ at 20 Å.
  
  - The correction for dependence of the wavelength scale with Solar Angle (up to $\pm 18 \text{ mÅ}$, depending on instrument and spectral order).

5 References

González-Riestra, R. 2008, XMM-SOC-CAL-TN-0082 [GR08]
### Table 6: List of Observations

<table>
<thead>
<tr>
<th>Obsid</th>
<th>Expid</th>
<th>Target</th>
<th>Date</th>
<th>Rev</th>
<th>Texp (sec)</th>
<th>Beta</th>
<th>$V_{bary}$</th>
<th>Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>1219201</td>
<td>R1S007</td>
<td>Capella</td>
<td>2000-03-25</td>
<td>54</td>
<td>52900</td>
<td>78</td>
<td>-27</td>
<td>22</td>
</tr>
<tr>
<td>1219201</td>
<td>R2S002</td>
<td>Capella</td>
<td>2000-03-25</td>
<td>54</td>
<td>51800</td>
<td>78</td>
<td>-27</td>
<td>22</td>
</tr>
<tr>
<td>1237202</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2000-05-01</td>
<td>72</td>
<td>49000</td>
<td>87</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>1237202</td>
<td>R1S008</td>
<td>AB Dor</td>
<td>2000-05-01</td>
<td>72</td>
<td>11800</td>
<td>87</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>1237202</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2000-05-01</td>
<td>72</td>
<td>47500</td>
<td>87</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>1237202</td>
<td>R2S009</td>
<td>AB Dor</td>
<td>2000-05-01</td>
<td>72</td>
<td>11500</td>
<td>87</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>1261302</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2000-06-07</td>
<td>91</td>
<td>57800</td>
<td>88</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>1261302</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2000-06-07</td>
<td>91</td>
<td>56000</td>
<td>88</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>1239401</td>
<td>R1S004</td>
<td>Procyon</td>
<td>2000-10-23</td>
<td>160</td>
<td>45100</td>
<td>94</td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>1239401</td>
<td>R2S005</td>
<td>Procyon</td>
<td>2000-10-23</td>
<td>160</td>
<td>44200</td>
<td>94</td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>1239401</td>
<td>R1S008</td>
<td>Procyon</td>
<td>2000-10-23</td>
<td>160</td>
<td>11800</td>
<td>94</td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>1239401</td>
<td>R2S009</td>
<td>Procyon</td>
<td>2000-10-23</td>
<td>160</td>
<td>47500</td>
<td>94</td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>1331201</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2000-12-11</td>
<td>185</td>
<td>57600</td>
<td>93</td>
<td>-1</td>
<td>9</td>
</tr>
<tr>
<td>1331201</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2000-12-11</td>
<td>185</td>
<td>56000</td>
<td>93</td>
<td>-1</td>
<td>9</td>
</tr>
<tr>
<td>1345203</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2001-01-20</td>
<td>205</td>
<td>51100</td>
<td>93</td>
<td>-2</td>
<td>9</td>
</tr>
<tr>
<td>1345203</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2001-01-20</td>
<td>205</td>
<td>49600</td>
<td>93</td>
<td>-2</td>
<td>9</td>
</tr>
<tr>
<td>1345403</td>
<td>R1S001</td>
<td>HR 1099</td>
<td>2001-02-07</td>
<td>214</td>
<td>3600</td>
<td>93</td>
<td>-29</td>
<td>9</td>
</tr>
<tr>
<td>1345403</td>
<td>R2S002</td>
<td>HR 1099</td>
<td>2001-02-07</td>
<td>214</td>
<td>3500</td>
<td>93</td>
<td>-29</td>
<td>9</td>
</tr>
<tr>
<td>1345207</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2001-05-22</td>
<td>266</td>
<td>48500</td>
<td>88</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>1345207</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2001-05-22</td>
<td>266</td>
<td>47200</td>
<td>88</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>1345404</td>
<td>R1S001</td>
<td>HR 1099</td>
<td>2001-08-18</td>
<td>310</td>
<td>25700</td>
<td>93</td>
<td>28</td>
<td>9</td>
</tr>
<tr>
<td>1345404</td>
<td>R2S002</td>
<td>HR 1099</td>
<td>2001-08-18</td>
<td>310</td>
<td>25000</td>
<td>93</td>
<td>28</td>
<td>9</td>
</tr>
<tr>
<td>1345405</td>
<td>R1S001</td>
<td>HR 1099</td>
<td>2001-08-18</td>
<td>310</td>
<td>10500</td>
<td>93</td>
<td>28</td>
<td>9</td>
</tr>
<tr>
<td>1345405</td>
<td>R2S002</td>
<td>HR 1099</td>
<td>2001-08-18</td>
<td>310</td>
<td>10200</td>
<td>93</td>
<td>28</td>
<td>9</td>
</tr>
<tr>
<td>1345213</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2001-10-13</td>
<td>338</td>
<td>38700</td>
<td>93</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>1345213</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2001-10-13</td>
<td>338</td>
<td>37600</td>
<td>93</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>1345214</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2001-12-26</td>
<td>375</td>
<td>5000</td>
<td>91</td>
<td>-2</td>
<td>9</td>
</tr>
<tr>
<td>1345214</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2001-12-26</td>
<td>375</td>
<td>4600</td>
<td>91</td>
<td>-2</td>
<td>9</td>
</tr>
<tr>
<td>1345216</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2002-04-12</td>
<td>429</td>
<td>51900</td>
<td>87</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>1345216</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2002-04-12</td>
<td>429</td>
<td>50400</td>
<td>87</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>1345218</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2002-11-05</td>
<td>532</td>
<td>19500</td>
<td>93</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>1345218</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2002-11-05</td>
<td>532</td>
<td>18800</td>
<td>93</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>1345219</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2002-11-15</td>
<td>537</td>
<td>19800</td>
<td>93</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>1345219</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2002-11-15</td>
<td>537</td>
<td>19800</td>
<td>93</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>1345220</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2002-12-03</td>
<td>546</td>
<td>19800</td>
<td>92</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>1345220</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2002-12-03</td>
<td>546</td>
<td>19800</td>
<td>92</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>Obsid</td>
<td>Expid</td>
<td>Target</td>
<td>Date</td>
<td>Rev</td>
<td>Texp (sec)</td>
<td>Beta</td>
<td>V_{bary}</td>
<td>Offset</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
<td>--------</td>
<td>--------------</td>
<td>-----</td>
<td>------------</td>
<td>------</td>
<td>----------</td>
<td>--------</td>
</tr>
<tr>
<td>1345221</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2002-12-30</td>
<td>560</td>
<td>48800</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>1345221</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2002-12-30</td>
<td>560</td>
<td>48800</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>1345222</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2003-01-23</td>
<td>572</td>
<td>51200</td>
<td>89</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>1345222</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2003-01-23</td>
<td>572</td>
<td>51200</td>
<td>89</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>1345223</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2003-03-30</td>
<td>605</td>
<td>48700</td>
<td>87</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1345223</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2003-03-30</td>
<td>605</td>
<td>48700</td>
<td>87</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1345224</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2003-05-31</td>
<td>636</td>
<td>19200</td>
<td>88</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1345224</td>
<td>R2S002</td>
<td>AB Dor</td>
<td>2003-05-31</td>
<td>636</td>
<td>19200</td>
<td>88</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1603625</td>
<td>R1U002</td>
<td>AB Dor</td>
<td>2003-08-02</td>
<td>668</td>
<td>13100</td>
<td>91</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>1603625</td>
<td>R2U002</td>
<td>AB Dor</td>
<td>2003-08-02</td>
<td>668</td>
<td>13100</td>
<td>91</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>1345407</td>
<td>R1S001</td>
<td>HR 1099</td>
<td>2004-02-14</td>
<td>766</td>
<td>40200</td>
<td>87</td>
<td>-29</td>
<td>0</td>
</tr>
<tr>
<td>1345407</td>
<td>R2S002</td>
<td>HR 1099</td>
<td>2004-02-14</td>
<td>766</td>
<td>40200</td>
<td>87</td>
<td>-29</td>
<td>0</td>
</tr>
<tr>
<td>1347208</td>
<td>R1S007</td>
<td>Capella</td>
<td>2004-04-01</td>
<td>790</td>
<td>62600</td>
<td>71</td>
<td>-26</td>
<td>2</td>
</tr>
<tr>
<td>1347208</td>
<td>R2S008</td>
<td>Capella</td>
<td>2004-04-01</td>
<td>790</td>
<td>1700</td>
<td>71</td>
<td>-26</td>
<td>2</td>
</tr>
<tr>
<td>1347208</td>
<td>R2U002</td>
<td>Capella</td>
<td>2004-04-01</td>
<td>790</td>
<td>60600</td>
<td>71</td>
<td>-26</td>
<td>2</td>
</tr>
<tr>
<td>1345408</td>
<td>R1S001</td>
<td>HR 1099</td>
<td>2004-08-13</td>
<td>857</td>
<td>51700</td>
<td>89</td>
<td>28</td>
<td>1</td>
</tr>
<tr>
<td>1345408</td>
<td>R2S002</td>
<td>HR 1099</td>
<td>2004-08-13</td>
<td>857</td>
<td>51600</td>
<td>89</td>
<td>28</td>
<td>1</td>
</tr>
<tr>
<td>1347215</td>
<td>R1S007</td>
<td>Capella</td>
<td>2004-09-10</td>
<td>871</td>
<td>67900</td>
<td>87</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>1347215</td>
<td>R2S008</td>
<td>Capella</td>
<td>2004-09-10</td>
<td>871</td>
<td>67800</td>
<td>87</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>1345409</td>
<td>R1S001</td>
<td>HR 1099</td>
<td>2005-01-29</td>
<td>942</td>
<td>55300</td>
<td>101</td>
<td>-28</td>
<td>1</td>
</tr>
<tr>
<td>1345409</td>
<td>R2S002</td>
<td>HR 1099</td>
<td>2005-01-29</td>
<td>942</td>
<td>55300</td>
<td>101</td>
<td>-28</td>
<td>1</td>
</tr>
<tr>
<td>1347216</td>
<td>R1S007</td>
<td>Capella</td>
<td>2005-03-28</td>
<td>971</td>
<td>23800</td>
<td>75</td>
<td>-27</td>
<td>2</td>
</tr>
<tr>
<td>1347216</td>
<td>R2S008</td>
<td>Capella</td>
<td>2005-03-28</td>
<td>971</td>
<td>23800</td>
<td>75</td>
<td>-27</td>
<td>2</td>
</tr>
<tr>
<td>1347217</td>
<td>R1S007</td>
<td>Capella</td>
<td>2005-03-31</td>
<td>972</td>
<td>16700</td>
<td>73</td>
<td>-26</td>
<td>2</td>
</tr>
<tr>
<td>1347217</td>
<td>R2S008</td>
<td>Capella</td>
<td>2005-03-31</td>
<td>972</td>
<td>16700</td>
<td>73</td>
<td>-26</td>
<td>2</td>
</tr>
<tr>
<td>1603630</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2005-04-18</td>
<td>981</td>
<td>51700</td>
<td>87</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1603630</td>
<td>R2S016</td>
<td>AB Dor</td>
<td>2005-04-18</td>
<td>981</td>
<td>51600</td>
<td>87</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1603632</td>
<td>R1S001</td>
<td>AB Dor</td>
<td>2005-10-16</td>
<td>1072</td>
<td>49700</td>
<td>93</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1603632</td>
<td>R2S016</td>
<td>AB Dor</td>
<td>2005-10-16</td>
<td>1072</td>
<td>49600</td>
<td>93</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1347220</td>
<td>R1S007</td>
<td>Capella</td>
<td>2006-03-20</td>
<td>1150</td>
<td>59300</td>
<td>82</td>
<td>-27</td>
<td>3</td>
</tr>
<tr>
<td>1347220</td>
<td>R2S008</td>
<td>Capella</td>
<td>2006-03-20</td>
<td>1150</td>
<td>59300</td>
<td>82</td>
<td>-27</td>
<td>3</td>
</tr>
<tr>
<td>4125801</td>
<td>R1S004</td>
<td>AB Dor</td>
<td>2006-12-31</td>
<td>1293</td>
<td>44900</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>4125801</td>
<td>R2S005</td>
<td>AB Dor</td>
<td>2006-12-31</td>
<td>1293</td>
<td>44800</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>1347221</td>
<td>R1S007</td>
<td>Capella</td>
<td>2007-02-20</td>
<td>1319</td>
<td>63800</td>
<td>108</td>
<td>-26</td>
<td>3</td>
</tr>
<tr>
<td>1347221</td>
<td>R2S008</td>
<td>Capella</td>
<td>2007-02-20</td>
<td>1319</td>
<td>59300</td>
<td>108</td>
<td>-26</td>
<td>3</td>
</tr>
<tr>
<td>4155801</td>
<td>R1S001</td>
<td>Procyon</td>
<td>2007-04-07</td>
<td>1342</td>
<td>44500</td>
<td>98</td>
<td>-28</td>
<td>16</td>
</tr>
<tr>
<td>4155801</td>
<td>R2S002</td>
<td>Procyon</td>
<td>2007-04-07</td>
<td>1342</td>
<td>44500</td>
<td>98</td>
<td>-28</td>
<td>16</td>
</tr>
<tr>
<td>4155802</td>
<td>R1S001</td>
<td>Procyon</td>
<td>2007-04-08</td>
<td>1342</td>
<td>33800</td>
<td>98</td>
<td>-28</td>
<td>9</td>
</tr>
<tr>
<td>4155802</td>
<td>R2S002</td>
<td>Procyon</td>
<td>2007-04-08</td>
<td>1342</td>
<td>33800</td>
<td>98</td>
<td>-28</td>
<td>9</td>
</tr>
<tr>
<td>4155803</td>
<td>R1S001</td>
<td>Procyon</td>
<td>2007-04-08</td>
<td>1342</td>
<td>38800</td>
<td>97</td>
<td>-28</td>
<td>10</td>
</tr>
<tr>
<td>4155803</td>
<td>R2S002</td>
<td>Procyon</td>
<td>2007-04-08</td>
<td>1342</td>
<td>38800</td>
<td>97</td>
<td>-28</td>
<td>10</td>
</tr>
<tr>
<td>4125802</td>
<td>R1S004</td>
<td>AB Dor</td>
<td>2007-07-19</td>
<td>1393</td>
<td>48700</td>
<td>91</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>4125802</td>
<td>R2S005</td>
<td>AB Dor</td>
<td>2007-07-19</td>
<td>1393</td>
<td>48700</td>
<td>91</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>5107801</td>
<td>R1S007</td>
<td>Capella</td>
<td>2007-08-27</td>
<td>1413</td>
<td>59900</td>
<td>74</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td>5107801</td>
<td>R2S008</td>
<td>Capella</td>
<td>2007-08-27</td>
<td>1413</td>
<td>60000</td>
<td>74</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td>4125803</td>
<td>R1S004</td>
<td>AB Dor</td>
<td>2008-01-03</td>
<td>1478</td>
<td>48700</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
</tbody>
</table>
Figure 6: Line shifts: RGS1 Order 1. Comparison of the shifts measured by CP07 with this work, with and without velocity correction. Numbers given in the plots are the median and the standard deviation of the distributions.

Table 6 – continued from previous page

<table>
<thead>
<tr>
<th>Obsid</th>
<th>Expid</th>
<th>Target</th>
<th>Date</th>
<th>Rev</th>
<th>Texp (sec)</th>
<th>Beta</th>
<th>$V_{\text{bary}}$</th>
<th>Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>4125803</td>
<td>R2S005</td>
<td>AB Dor</td>
<td>2008-01-03</td>
<td>1478</td>
<td>48700</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>5107802</td>
<td>R1S007</td>
<td>Capella</td>
<td>2008-09-17</td>
<td>1607</td>
<td>54000</td>
<td>93</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>5107802</td>
<td>R2S008</td>
<td>Capella</td>
<td>2008-09-17</td>
<td>1607</td>
<td>54100</td>
<td>93</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>4125804</td>
<td>R1S004</td>
<td>AB Dor</td>
<td>2009-01-04</td>
<td>1662</td>
<td>47300</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>4125804</td>
<td>R2S005</td>
<td>AB Dor</td>
<td>2009-01-04</td>
<td>1662</td>
<td>47000</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>5107804</td>
<td>R1S007</td>
<td>Capella</td>
<td>2009-09-29</td>
<td>1796</td>
<td>61500</td>
<td>103</td>
<td>26</td>
<td>5</td>
</tr>
<tr>
<td>5107804</td>
<td>R2S008</td>
<td>Capella</td>
<td>2009-09-29</td>
<td>1796</td>
<td>61600</td>
<td>103</td>
<td>26</td>
<td>5</td>
</tr>
<tr>
<td>4125806</td>
<td>R1S004</td>
<td>AB Dor</td>
<td>2010-01-11</td>
<td>1848</td>
<td>49700</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>4125806</td>
<td>R2S005</td>
<td>AB Dor</td>
<td>2010-01-11</td>
<td>1848</td>
<td>49800</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>5107805</td>
<td>R1S007</td>
<td>Capella</td>
<td>2010-08-24</td>
<td>1961</td>
<td>59500</td>
<td>71</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>5107805</td>
<td>R2S008</td>
<td>Capella</td>
<td>2010-08-24</td>
<td>1961</td>
<td>59600</td>
<td>71</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>4125807</td>
<td>R1S004</td>
<td>AB Dor</td>
<td>2011-01-02</td>
<td>2027</td>
<td>1400</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>4125807</td>
<td>R1U002</td>
<td>AB Dor</td>
<td>2011-01-02</td>
<td>2027</td>
<td>55900</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>4125807</td>
<td>R2S005</td>
<td>AB Dor</td>
<td>2011-01-02</td>
<td>2027</td>
<td>55500</td>
<td>90</td>
<td>-2</td>
<td>0</td>
</tr>
</tbody>
</table>

$V_{\text{bary}}$: Barycentric velocity correction (km s$^{-1}$)
Offset: Offset from boresight (arcsec)

Table 7: Line shifts: RGS1 Order 1

<table>
<thead>
<tr>
<th>Obsid</th>
<th>Target</th>
<th>Rev</th>
<th>CP07</th>
<th>GR12</th>
<th>GR12v</th>
<th>nl</th>
</tr>
</thead>
<tbody>
<tr>
<td>01219201</td>
<td>Capella</td>
<td>54</td>
<td>4.4</td>
<td>8.6±0.3 (2.8)</td>
<td>5.2±0.3 (3.5)</td>
<td>8</td>
</tr>
<tr>
<td>01237202</td>
<td>AB Dor</td>
<td>72</td>
<td>8.2</td>
<td>4.8±0.6 (4.5)</td>
<td>3.1±0.6 (5.1)</td>
<td>7</td>
</tr>
<tr>
<td>01261302</td>
<td>AB Dor</td>
<td>91</td>
<td>4.8</td>
<td>4.7±0.6 (4.1)</td>
<td>3.0±0.6 (4.6)</td>
<td>7</td>
</tr>
<tr>
<td>01239401</td>
<td>Procyon</td>
<td>160</td>
<td>-0.2</td>
<td>-2.5±0.9 (5.0)</td>
<td>0.1±0.9 (4.3)</td>
<td>4</td>
</tr>
<tr>
<td>01239402</td>
<td>Procyon</td>
<td>160</td>
<td>-3.3</td>
<td>-6.6±0.9 (5.6)</td>
<td>-4.0±0.9 (5.1)</td>
<td>4</td>
</tr>
<tr>
<td>Obsid</td>
<td>Target</td>
<td>Rev</td>
<td>CP07</td>
<td>GR12</td>
<td>GR12v</td>
<td>nl</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>-----</td>
<td>------</td>
<td>-------</td>
<td>-------</td>
<td>----</td>
</tr>
<tr>
<td>01237203</td>
<td>AB Dor</td>
<td>102</td>
<td>1.2</td>
<td>2.2±0.5 (4.5)</td>
<td>0.2±0.5 (5.2)</td>
<td>6</td>
</tr>
<tr>
<td>01331201</td>
<td>AB Dor</td>
<td>185</td>
<td>0.1</td>
<td>0.3±0.5 (3.7)</td>
<td>-1.8±0.5 (4.3)</td>
<td>7</td>
</tr>
<tr>
<td>01331207</td>
<td>AB Dor</td>
<td>185</td>
<td>4.4</td>
<td>4.3±1.3 (6.0)</td>
<td>2.3±1.3 (6.1)</td>
<td>3</td>
</tr>
<tr>
<td>01345203</td>
<td>AB Dor</td>
<td>205</td>
<td>-4.3</td>
<td>0.1±0.6 (4.5)</td>
<td>-2.1±0.6 (5.1)</td>
<td>6</td>
</tr>
<tr>
<td>01345401</td>
<td>HR 1099</td>
<td>221</td>
<td>10.8</td>
<td>9.3±0.5 (2.3)</td>
<td>8.5±0.5 (2.6)</td>
<td>6</td>
</tr>
<tr>
<td>01347201</td>
<td>Capella</td>
<td>232</td>
<td>2.9</td>
<td>5.6±0.4 (4.1)</td>
<td>2.2±0.4 (4.7)</td>
<td>7</td>
</tr>
<tr>
<td>01345207</td>
<td>AB Dor</td>
<td>266</td>
<td>8.6</td>
<td>7.6±0.7 (5.0)</td>
<td>5.7±0.7 (5.4)</td>
<td>6</td>
</tr>
<tr>
<td>01345404</td>
<td>HR 1099</td>
<td>310</td>
<td>10.8</td>
<td>9.3±0.5 (2.3)</td>
<td>8.5±0.5 (2.6)</td>
<td>6</td>
</tr>
<tr>
<td>01347201</td>
<td>Capella</td>
<td>232</td>
<td>2.9</td>
<td>5.6±0.4 (4.1)</td>
<td>2.2±0.4 (4.7)</td>
<td>7</td>
</tr>
<tr>
<td>01345207</td>
<td>AB Dor</td>
<td>266</td>
<td>8.6</td>
<td>7.6±0.7 (5.0)</td>
<td>5.7±0.7 (5.4)</td>
<td>6</td>
</tr>
<tr>
<td>01345404</td>
<td>HR 1099</td>
<td>310</td>
<td>10.8</td>
<td>9.3±0.5 (2.3)</td>
<td>8.5±0.5 (2.6)</td>
<td>6</td>
</tr>
<tr>
<td>01347201</td>
<td>Capella</td>
<td>232</td>
<td>2.9</td>
<td>5.6±0.4 (4.1)</td>
<td>2.2±0.4 (4.7)</td>
<td>7</td>
</tr>
<tr>
<td>01345207</td>
<td>AB Dor</td>
<td>266</td>
<td>8.6</td>
<td>7.6±0.7 (5.0)</td>
<td>5.7±0.7 (5.4)</td>
<td>6</td>
</tr>
<tr>
<td>01345404</td>
<td>HR 1099</td>
<td>310</td>
<td>10.8</td>
<td>9.3±0.5 (2.3)</td>
<td>8.5±0.5 (2.6)</td>
<td>6</td>
</tr>
<tr>
<td>01347201</td>
<td>Capella</td>
<td>232</td>
<td>2.9</td>
<td>5.6±0.4 (4.1)</td>
<td>2.2±0.4 (4.7)</td>
<td>7</td>
</tr>
<tr>
<td>01345207</td>
<td>AB Dor</td>
<td>266</td>
<td>8.6</td>
<td>7.6±0.7 (5.0)</td>
<td>5.7±0.7 (5.4)</td>
<td>6</td>
</tr>
<tr>
<td>01345404</td>
<td>HR 1099</td>
<td>310</td>
<td>10.8</td>
<td>9.3±0.5 (2.3)</td>
<td>8.5±0.5 (2.6)</td>
<td>6</td>
</tr>
<tr>
<td>01347201</td>
<td>Capella</td>
<td>232</td>
<td>2.9</td>
<td>5.6±0.4 (4.1)</td>
<td>2.2±0.4 (4.7)</td>
<td>7</td>
</tr>
<tr>
<td>01345207</td>
<td>AB Dor</td>
<td>266</td>
<td>8.6</td>
<td>7.6±0.7 (5.0)</td>
<td>5.7±0.7 (5.4)</td>
<td>6</td>
</tr>
<tr>
<td>01345404</td>
<td>HR 1099</td>
<td>310</td>
<td>10.8</td>
<td>9.3±0.5 (2.3)</td>
<td>8.5±0.5 (2.6)</td>
<td>6</td>
</tr>
<tr>
<td>01347201</td>
<td>Capella</td>
<td>232</td>
<td>2.9</td>
<td>5.6±0.4 (4.1)</td>
<td>2.2±0.4 (4.7)</td>
<td>7</td>
</tr>
<tr>
<td>01345207</td>
<td>AB Dor</td>
<td>266</td>
<td>8.6</td>
<td>7.6±0.7 (5.0)</td>
<td>5.7±0.7 (5.4)</td>
<td>6</td>
</tr>
<tr>
<td>01345404</td>
<td>HR 1099</td>
<td>310</td>
<td>10.8</td>
<td>9.3±0.5 (2.3)</td>
<td>8.5±0.5 (2.6)</td>
<td>6</td>
</tr>
<tr>
<td>01347201</td>
<td>Capella</td>
<td>232</td>
<td>2.9</td>
<td>5.6±0.4 (4.1)</td>
<td>2.2±0.4 (4.7)</td>
<td>7</td>
</tr>
</tbody>
</table>
Table 8: Line shifts: RGS2 Order 1

<table>
<thead>
<tr>
<th>Obsid</th>
<th>Target</th>
<th>Rev</th>
<th>CP07</th>
<th>GR12</th>
<th>GR12v</th>
<th>nl</th>
</tr>
</thead>
<tbody>
<tr>
<td>01219201</td>
<td>Capella</td>
<td>54</td>
<td>9.5</td>
<td>10.9±0.3 (2.9)</td>
<td>7.6±0.3 (3.7)</td>
<td>7</td>
</tr>
<tr>
<td>01237202</td>
<td>AB Dor</td>
<td>72</td>
<td>12.2</td>
<td>8.5±0.6 (5.0)</td>
<td>6.8±0.6 (5.8)</td>
<td>6</td>
</tr>
<tr>
<td>01261302</td>
<td>AB Dor</td>
<td>91</td>
<td>10.1</td>
<td>9.5±0.5 (4.6)</td>
<td>7.8±0.5 (5.2)</td>
<td>6</td>
</tr>
<tr>
<td>01239401</td>
<td>Procyon</td>
<td>160</td>
<td>3.1</td>
<td>-1.1±1.3 (7.0)</td>
<td>1.8±1.3 (6.2)</td>
<td>3</td>
</tr>
<tr>
<td>01239402</td>
<td>Procyon</td>
<td>160</td>
<td>-0.6</td>
<td>-0.4±1.2 (8.5)</td>
<td>2.3±1.2 (7.7)</td>
<td>3</td>
</tr>
<tr>
<td>01237203</td>
<td>AB Dor</td>
<td>162</td>
<td>6.6</td>
<td>6.8±0.5 (2.0)</td>
<td>5.0±0.5 (2.6)</td>
<td>6</td>
</tr>
<tr>
<td>01331201</td>
<td>AB Dor</td>
<td>185</td>
<td>5.4</td>
<td>5.5±0.5 (2.3)</td>
<td>3.7±0.5 (2.7)</td>
<td>6</td>
</tr>
<tr>
<td>01331207</td>
<td>AB Dor</td>
<td>185</td>
<td>4.9</td>
<td>7.0±1.2 (6.4)</td>
<td>5.0±1.2 (7.2)</td>
<td>5</td>
</tr>
<tr>
<td>01345203</td>
<td>AB Dor</td>
<td>205</td>
<td>2.4</td>
<td>2.7±0.6 (4.0)</td>
<td>0.9±0.6 (4.7)</td>
<td>6</td>
</tr>
<tr>
<td>01345403</td>
<td>HR 1099</td>
<td>214</td>
<td>4.2</td>
<td>6.9±1.6 (1.6)</td>
<td>6.2±1.6 (1.5)</td>
<td>3</td>
</tr>
<tr>
<td>01345401</td>
<td>HR 1099</td>
<td>221</td>
<td>17.3</td>
<td>14.5±0.5 (3.0)</td>
<td>13.8±0.5 (3.1)</td>
<td>6</td>
</tr>
<tr>
<td>01347201</td>
<td>Capella</td>
<td>232</td>
<td>9.0</td>
<td>10.5±0.4 (1.6)</td>
<td>7.3±0.4 (2.9)</td>
<td>6</td>
</tr>
<tr>
<td>01345207</td>
<td>AB Dor</td>
<td>266</td>
<td>13.3</td>
<td>11.9±0.6 (4.5)</td>
<td>10.2±0.6 (5.0)</td>
<td>6</td>
</tr>
<tr>
<td>01345404</td>
<td>HR 1099</td>
<td>310</td>
<td>14.5</td>
<td>13.8±0.7 (4.5)</td>
<td>16.2±0.7 (4.1)</td>
<td>6</td>
</tr>
<tr>
<td>01345405</td>
<td>HR 1099</td>
<td>310</td>
<td>21.5</td>
<td>17.4±1.2 (4.7)</td>
<td>19.9±1.2 (3.1)</td>
<td>3</td>
</tr>
<tr>
<td>01345213</td>
<td>AB Dor</td>
<td>338</td>
<td>20.7</td>
<td>17.9±0.6 (4.0)</td>
<td>16.1±0.6 (4.4)</td>
<td>6</td>
</tr>
<tr>
<td>01345214</td>
<td>AB Dor</td>
<td>375</td>
<td>14.3</td>
<td>16.0±1.7 (1.0)</td>
<td>14.2±1.7 (1.5)</td>
<td>2</td>
</tr>
<tr>
<td>01345215</td>
<td>AB Dor</td>
<td>429</td>
<td>14.0</td>
<td>13.5±0.6 (4.4)</td>
<td>11.8±0.6 (5.2)</td>
<td>6</td>
</tr>
<tr>
<td>01345216</td>
<td>AB Dor</td>
<td>462</td>
<td>16.0</td>
<td>13.7±0.6 (4.0)</td>
<td>12.0±0.6 (4.7)</td>
<td>6</td>
</tr>
<tr>
<td>01345406</td>
<td>HR 1099</td>
<td>495</td>
<td>-0.2</td>
<td>2.3±0.6 (5.2)</td>
<td>4.7±0.6 (4.2)</td>
<td>6</td>
</tr>
<tr>
<td>01347204</td>
<td>Capella</td>
<td>517</td>
<td>3.1</td>
<td>6.7±0.4 (4.4)</td>
<td>6.5±0.4 (4.5)</td>
<td>7</td>
</tr>
<tr>
<td>01345218</td>
<td>AB Dor</td>
<td>532</td>
<td>17.4</td>
<td>14.0±0.7 (5.9)</td>
<td>12.1±0.7 (5.5)</td>
<td>5</td>
</tr>
<tr>
<td>01345217</td>
<td>AB Dor</td>
<td>537</td>
<td>11.3</td>
<td>11.3±0.8 (2.5)</td>
<td>9.4±0.8 (2.8)</td>
<td>6</td>
</tr>
<tr>
<td>01345220</td>
<td>AB Dor</td>
<td>546</td>
<td>0.7</td>
<td>1.8±0.8 (5.2)</td>
<td>-0.1±0.8 (5.0)</td>
<td>6</td>
</tr>
<tr>
<td>01345221</td>
<td>AB Dor</td>
<td>560</td>
<td>1.4</td>
<td>2.5±0.5 (5.1)</td>
<td>0.6±0.5 (4.8)</td>
<td>6</td>
</tr>
<tr>
<td>01345222</td>
<td>AB Dor</td>
<td>572</td>
<td>11.1</td>
<td>9.5±0.5 (4.2)</td>
<td>7.6±0.5 (3.5)</td>
<td>6</td>
</tr>
<tr>
<td>01345223</td>
<td>AB Dor</td>
<td>605</td>
<td>15.5</td>
<td>12.8±0.5 (4.2)</td>
<td>11.0±0.5 (3.6)</td>
<td>6</td>
</tr>
<tr>
<td>01345224</td>
<td>AB Dor</td>
<td>636</td>
<td>26.7</td>
<td>20.8±0.9 (3.5)</td>
<td>19.1±0.9 (2.9)</td>
<td>6</td>
</tr>
</tbody>
</table>

Figure 7: As Fig. 6 for RGS2 Order 1.
<table>
<thead>
<tr>
<th>Obsid</th>
<th>Target</th>
<th>Rev</th>
<th>CP07</th>
<th>GR12</th>
<th>GR12v</th>
<th>nl</th>
</tr>
</thead>
<tbody>
<tr>
<td>01603625</td>
<td>AB Dor</td>
<td>668</td>
<td>8.8</td>
<td>7.4±1.0 (4.7)</td>
<td>5.7±1.0 (4.2)</td>
<td>4</td>
</tr>
<tr>
<td>01603626</td>
<td>AB Dor</td>
<td>668</td>
<td>14.1</td>
<td>12.6±0.7 (6.2)</td>
<td>10.9±0.7 (5.7)</td>
<td>6</td>
</tr>
<tr>
<td>01603627</td>
<td>AB Dor</td>
<td>709</td>
<td>6.0</td>
<td>5.7±0.7 (3.8)</td>
<td>4.0±0.7 (3.7)</td>
<td>6</td>
</tr>
<tr>
<td>01603628</td>
<td>AB Dor</td>
<td>732</td>
<td>0.4</td>
<td>1.2±0.5 (2.9)</td>
<td>-0.7±0.5 (2.2)</td>
<td>6</td>
</tr>
<tr>
<td>01345407</td>
<td>HR 1099</td>
<td>766</td>
<td></td>
<td>7.5±0.5 (4.8)</td>
<td>6.8±0.5 (4.5)</td>
<td>6</td>
</tr>
<tr>
<td>01347208</td>
<td>Capella</td>
<td>790</td>
<td>19.7</td>
<td>19.9±0.3 (7.3)</td>
<td>16.7±0.3 (5.8)</td>
<td>6</td>
</tr>
<tr>
<td>01345408</td>
<td>HR 1099</td>
<td>857</td>
<td>10.7</td>
<td>9.5±0.4 (3.3)</td>
<td>11.9±0.4 (3.0)</td>
<td>7</td>
</tr>
<tr>
<td>01347215</td>
<td>Capella</td>
<td>871</td>
<td>8.5</td>
<td>12.9±0.3 (2.4)</td>
<td>12.7±0.3 (2.3)</td>
<td>6</td>
</tr>
<tr>
<td>01345409</td>
<td>HR 1099</td>
<td>942</td>
<td>-4.8</td>
<td>-3.3±0.4 (3.2)</td>
<td>-4.0±0.4 (3.3)</td>
<td>7</td>
</tr>
<tr>
<td>01347216</td>
<td>Capella</td>
<td>971</td>
<td>15.6</td>
<td>19.6±0.4 (4.9)</td>
<td>16.5±0.4 (3.4)</td>
<td>7</td>
</tr>
<tr>
<td>01347217</td>
<td>Capella</td>
<td>972</td>
<td>19.7</td>
<td>20.4±0.4 (2.9)</td>
<td>17.3±0.4 (1.8)</td>
<td>6</td>
</tr>
<tr>
<td>01603630</td>
<td>AB Dor</td>
<td>981</td>
<td>15.6</td>
<td>13.2±0.5 (3.3)</td>
<td>11.5±0.5 (3.1)</td>
<td>6</td>
</tr>
<tr>
<td>01603632</td>
<td>AB Dor</td>
<td>1072</td>
<td>12.5</td>
<td>12.2±0.5 (2.9)</td>
<td>10.4±0.5 (2.1)</td>
<td>6</td>
</tr>
<tr>
<td>01347220</td>
<td>Capella</td>
<td>1150</td>
<td>17.8</td>
<td>18.2±0.4 (5.3)</td>
<td>14.7±0.4 (3.4)</td>
<td>5</td>
</tr>
<tr>
<td>04125801</td>
<td>AB Dor</td>
<td>1293</td>
<td>-2.5</td>
<td>-0.9±0.6 (1.5)</td>
<td>-2.8±0.6 (1.9)</td>
<td>6</td>
</tr>
<tr>
<td>01347221</td>
<td>Capella</td>
<td>1319</td>
<td>-11.3</td>
<td>-3.7±0.4 (1.8)</td>
<td>-7.0±0.4 (1.9)</td>
<td>6</td>
</tr>
<tr>
<td>04155801</td>
<td>Procyon</td>
<td>1342</td>
<td>11.8</td>
<td>9.9±1.4 (2.8)</td>
<td>7.8±1.4 (2.2)</td>
<td>3</td>
</tr>
<tr>
<td>04155802</td>
<td>Procyon</td>
<td>1342</td>
<td>6.8</td>
<td>3.4±1.7 (2.9)</td>
<td>1.4±1.7 (3.3)</td>
<td>3</td>
</tr>
<tr>
<td>04155803</td>
<td>Procyon</td>
<td>1342</td>
<td>-1.5</td>
<td>-0.7±1.7 (6.2)</td>
<td>-2.8±1.7 (6.7)</td>
<td>3</td>
</tr>
<tr>
<td>04125802</td>
<td>AB Dor</td>
<td>1393</td>
<td></td>
<td>11.3±0.5 (3.1)</td>
<td>9.6±0.5 (2.9)</td>
<td>6</td>
</tr>
<tr>
<td>05107801</td>
<td>Capella</td>
<td>1413</td>
<td>15.6</td>
<td>21.9±0.3 (2.6)</td>
<td>21.8±0.3 (2.5)</td>
<td>6</td>
</tr>
<tr>
<td>04125803</td>
<td>AB Dor</td>
<td>1478</td>
<td>-1.5</td>
<td>-1.5±0.6 (2.1)</td>
<td>-3.4±0.6 (1.6)</td>
<td>6</td>
</tr>
<tr>
<td>05107802</td>
<td>Capella</td>
<td>1607</td>
<td></td>
<td>7.4±0.3 (1.7)</td>
<td>7.3±0.3 (1.7)</td>
<td>6</td>
</tr>
<tr>
<td>04125804</td>
<td>AB Dor</td>
<td>1662</td>
<td></td>
<td>3.3±0.6 (3.3)</td>
<td>1.5±0.6 (2.7)</td>
<td>6</td>
</tr>
<tr>
<td>05107804</td>
<td>Capella</td>
<td>1796</td>
<td></td>
<td>1.8±0.3 (2.1)</td>
<td>1.7±0.3 (2.0)</td>
<td>6</td>
</tr>
<tr>
<td>04125806</td>
<td>AB Dor</td>
<td>1848</td>
<td></td>
<td>1.3±0.6 (3.4)</td>
<td>-0.6±0.6 (2.7)</td>
<td>6</td>
</tr>
<tr>
<td>05107805</td>
<td>Capella</td>
<td>1961</td>
<td></td>
<td>18.5±0.3 (3.1)</td>
<td>18.3±0.3 (3.0)</td>
<td>7</td>
</tr>
<tr>
<td>04125807</td>
<td>AB Dor</td>
<td>2027</td>
<td></td>
<td>10.5±0.6 (4.3)</td>
<td>8.6±0.6 (3.6)</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 8 – continued from previous page

<table>
<thead>
<tr>
<th>Obsid</th>
<th>Target</th>
<th>Rev</th>
<th>CP07</th>
<th>GR12</th>
<th>GR12v</th>
<th>nl</th>
</tr>
</thead>
<tbody>
<tr>
<td>01219201</td>
<td>Capella</td>
<td>54</td>
<td>1.7</td>
<td>2.4±0.4 (5.3)</td>
<td>-0.5±0.4 (5.0)</td>
<td>5</td>
</tr>
<tr>
<td>01237202</td>
<td>AB Dor</td>
<td>72</td>
<td>2.6</td>
<td>2.4±0.9 (2.7)</td>
<td>1.0±0.9 (3.0)</td>
<td>3</td>
</tr>
<tr>
<td>01261302</td>
<td>AB Dor</td>
<td>91</td>
<td>-0.2</td>
<td>0.9±0.9 (4.4)</td>
<td>-0.6±0.9 (4.5)</td>
<td>3</td>
</tr>
<tr>
<td>01237203</td>
<td>AB Dor</td>
<td>162</td>
<td>0.3</td>
<td>1.9±0.8 (3.0)</td>
<td>0.3±0.8 (3.2)</td>
<td>3</td>
</tr>
<tr>
<td>01331201</td>
<td>AB Dor</td>
<td>185</td>
<td>-0.7</td>
<td>0.9±0.7 (2.1)</td>
<td>-0.7±0.7 (2.3)</td>
<td>4</td>
</tr>
<tr>
<td>01331207</td>
<td>AB Dor</td>
<td>185</td>
<td>-0.2</td>
<td>1.3±2.1 (0.8)</td>
<td>-0.2±2.1 (0.3)</td>
<td>2</td>
</tr>
<tr>
<td>01454203</td>
<td>AB Dor</td>
<td>205</td>
<td>-4.3</td>
<td>-1.6±0.7 (2.2)</td>
<td>-3.2±0.7 (2.5)</td>
<td>3</td>
</tr>
<tr>
<td>01454201</td>
<td>HR 1099</td>
<td>221</td>
<td>4.4</td>
<td>4.8±0.7 (2.6)</td>
<td>4.1±0.7 (2.5)</td>
<td>4</td>
</tr>
<tr>
<td>01474201</td>
<td>Capella</td>
<td>232</td>
<td>0.2</td>
<td>1.0±0.6 (2.9)</td>
<td>-1.9±0.6 (3.5)</td>
<td>5</td>
</tr>
<tr>
<td>01454207</td>
<td>AB Dor</td>
<td>266</td>
<td>2.2</td>
<td>3.9±0.8 (1.8)</td>
<td>2.4±0.8 (2.1)</td>
<td>3</td>
</tr>
<tr>
<td>01454204</td>
<td>HR 1099</td>
<td>310</td>
<td>2.4</td>
<td>3.8±1.0 (6.9)</td>
<td>5.9±1.0 (6.7)</td>
<td>3</td>
</tr>
<tr>
<td>01454205</td>
<td>HR 1099</td>
<td>310</td>
<td>8.1</td>
<td>10.0±1.6 (4.6)</td>
<td>12.0±1.6 (3.9)</td>
<td>2</td>
</tr>
<tr>
<td>01452135</td>
<td>AB Dor</td>
<td>338</td>
<td>6.2</td>
<td>5.4±0.9 (1.5)</td>
<td>3.9±0.9 (1.9)</td>
<td>3</td>
</tr>
<tr>
<td>01452144</td>
<td>AB Dor</td>
<td>375</td>
<td>1.1</td>
<td>2.1±3.2 (3.8)</td>
<td>0±3.2 (4.4)</td>
<td>2</td>
</tr>
<tr>
<td>01452155</td>
<td>AB Dor</td>
<td>429</td>
<td>1.4</td>
<td>4.1±0.8 (3.9)</td>
<td>2.6±0.8 (4.1)</td>
<td>3</td>
</tr>
<tr>
<td>01452165</td>
<td>AB Dor</td>
<td>462</td>
<td>3.8</td>
<td>3.9±0.8 (2.7)</td>
<td>2.5±0.8 (3.0)</td>
<td>3</td>
</tr>
<tr>
<td>01454206</td>
<td>HR 1099</td>
<td>495</td>
<td>-4.8</td>
<td>-3.2±0.8 (4.5)</td>
<td>-1.0±0.8 (4.1)</td>
<td>3</td>
</tr>
<tr>
<td>01474204</td>
<td>Capella</td>
<td>517</td>
<td>-3.5</td>
<td>-1.8±0.6 (5.9)</td>
<td>-2.0±0.6 (5.9)</td>
<td>5</td>
</tr>
<tr>
<td>01452181</td>
<td>AB Dor</td>
<td>532</td>
<td>1.2</td>
<td>3.7±1.3 (2.0)</td>
<td>2.1±1.3 (2.5)</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 9: Line shifts: RGS1 Order 2
<table>
<thead>
<tr>
<th>Obsid</th>
<th>Target</th>
<th>Rev</th>
<th>CP07</th>
<th>GR12</th>
<th>GR12v</th>
<th>nl</th>
</tr>
</thead>
<tbody>
<tr>
<td>01345217</td>
<td>AB Dor</td>
<td>537</td>
<td>6.3</td>
<td>6.8±1.2 (3.1)</td>
<td>5.2±1.2 (2.7)</td>
<td>3</td>
</tr>
<tr>
<td>01345220</td>
<td>AB Dor</td>
<td>546</td>
<td>0.7</td>
<td>2.6±1.3 (4.5)</td>
<td>1.1±1.3 (4.3)</td>
<td>3</td>
</tr>
<tr>
<td>01345221</td>
<td>AB Dor</td>
<td>560</td>
<td>0.4</td>
<td>1.7±0.7 (1.9)</td>
<td>0.0±0.7 (1.8)</td>
<td>4</td>
</tr>
<tr>
<td>01345222</td>
<td>AB Dor</td>
<td>572</td>
<td>6.6</td>
<td>5.5±0.8 (2.4)</td>
<td>3.9±0.8 (2.4)</td>
<td>4</td>
</tr>
<tr>
<td>01345223</td>
<td>AB Dor</td>
<td>605</td>
<td>8.6</td>
<td>8.2±0.7 (3.7)</td>
<td>6.6±0.7 (3.6)</td>
<td>3</td>
</tr>
<tr>
<td>01345224</td>
<td>AB Dor</td>
<td>636</td>
<td>9.9</td>
<td>8.9±1.3 (1.5)</td>
<td>7.4±1.3 (1.7)</td>
<td>3</td>
</tr>
<tr>
<td>01603625</td>
<td>AB Dor</td>
<td>668</td>
<td>4.1±1.6 (3.7)</td>
<td>2.7±1.6 (3.2)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>01603626</td>
<td>AB Dor</td>
<td>668</td>
<td>8.1</td>
<td>7.9±1.2 (0.6)</td>
<td>6.5±1.2 (0.7)</td>
<td>3</td>
</tr>
<tr>
<td>01603627</td>
<td>AB Dor</td>
<td>709</td>
<td>3.8</td>
<td>4.9±1.1 (2.6)</td>
<td>3.3±1.1 (2.2)</td>
<td>3</td>
</tr>
<tr>
<td>01603628</td>
<td>AB Dor</td>
<td>732</td>
<td>-0.7</td>
<td>0.1±0.7 (1.6)</td>
<td>-1.5±0.7 (1.8)</td>
<td>3</td>
</tr>
<tr>
<td>01345407</td>
<td>HR 1099</td>
<td>766</td>
<td>4.7±0.7 (5.4)</td>
<td>4.1±0.7 (5.3)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>01347208</td>
<td>Capella</td>
<td>790</td>
<td>9.4</td>
<td>9.9±0.4 (3.2)</td>
<td>7.1±0.4 (2.5)</td>
<td>5</td>
</tr>
<tr>
<td>01345408</td>
<td>HR 1099</td>
<td>857</td>
<td>4.3±0.7 (3.2)</td>
<td>6.4±0.7 (2.8)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>01347215</td>
<td>Capella</td>
<td>871</td>
<td>3.9</td>
<td>3.9±0.4 (4.0)</td>
<td>3.8±0.4 (4.0)</td>
<td>5</td>
</tr>
<tr>
<td>01345409</td>
<td>HR 1099</td>
<td>942</td>
<td>-3.5</td>
<td>-1.8±0.7 (1.0)</td>
<td>-2.3±0.7 (1.1)</td>
<td>3</td>
</tr>
<tr>
<td>01347216</td>
<td>Capella</td>
<td>971</td>
<td>9.5</td>
<td>9.8±0.7 (3.3)</td>
<td>7.1±0.7 (3.1)</td>
<td>5</td>
</tr>
<tr>
<td>01347217</td>
<td>Capella</td>
<td>972</td>
<td>8.6</td>
<td>10.9±0.8 (5.3)</td>
<td>8.2±0.8 (4.7)</td>
<td>5</td>
</tr>
<tr>
<td>01603630</td>
<td>AB Dor</td>
<td>981</td>
<td>7.9</td>
<td>7.0±0.8 (3.2)</td>
<td>5.5±0.8 (3.2)</td>
<td>3</td>
</tr>
<tr>
<td>01603632</td>
<td>AB Dor</td>
<td>1072</td>
<td>6.6</td>
<td>5.8±0.8 (1.4)</td>
<td>4.3±0.8 (1.3)</td>
<td>4</td>
</tr>
<tr>
<td>01347220</td>
<td>Capella</td>
<td>1150</td>
<td>7.2</td>
<td>8.4±0.5 (6.9)</td>
<td>5.8±0.5 (6.4)</td>
<td>3</td>
</tr>
<tr>
<td>04125801</td>
<td>AB Dor</td>
<td>1293</td>
<td>-2.5</td>
<td>1.2±1.1 (4.4)</td>
<td>-0.3±1.1 (4.1)</td>
<td>3</td>
</tr>
<tr>
<td>01347221</td>
<td>Capella</td>
<td>1319</td>
<td>-4.2</td>
<td>-2.6±0.4 (2.2)</td>
<td>-5.3±0.4 (1.6)</td>
<td>4</td>
</tr>
<tr>
<td>04125802</td>
<td>AB Dor</td>
<td>1393</td>
<td>4.2±1.2 (1.7)</td>
<td>3.0±1.2 (1.5)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>05107801</td>
<td>Capella</td>
<td>1413</td>
<td>6.3</td>
<td>8.9±0.5 (2.6)</td>
<td>8.7±0.5 (2.6)</td>
<td>3</td>
</tr>
<tr>
<td>04125803</td>
<td>AB Dor</td>
<td>1478</td>
<td>-2.2±0.9 (2.7)</td>
<td>-3.9±0.9 (2.7)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>05107802</td>
<td>Capella</td>
<td>1607</td>
<td>1.6±0.4 (4.1)</td>
<td>1.5±0.4 (4.1)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>04125804</td>
<td>AB Dor</td>
<td>1662</td>
<td>2.2±0.8 (0.4)</td>
<td>0.6±0.8 (0.3)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>05107804</td>
<td>Capella</td>
<td>1796</td>
<td>-1.5±0.4 (4.1)</td>
<td>-1.7±0.4 (4.1)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>04125806</td>
<td>AB Dor</td>
<td>1848</td>
<td>1.3±0.9 (1.3)</td>
<td>-0.4±0.9 (0.9)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>05107805</td>
<td>Capella</td>
<td>1961</td>
<td>8.1±0.5 (3.5)</td>
<td>7.9±0.5 (3.5)</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Table 9 – continued from previous page

<table>
<thead>
<tr>
<th>Table 10: Line shifts: RGS2 Order 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obsid</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>01219201</td>
</tr>
<tr>
<td>01237202</td>
</tr>
<tr>
<td>01261302</td>
</tr>
<tr>
<td>01237203</td>
</tr>
<tr>
<td>01331201</td>
</tr>
<tr>
<td>01345203</td>
</tr>
<tr>
<td>01345401</td>
</tr>
<tr>
<td>01347201</td>
</tr>
<tr>
<td>01345207</td>
</tr>
<tr>
<td>01345404</td>
</tr>
<tr>
<td>01345213</td>
</tr>
<tr>
<td>01345215</td>
</tr>
<tr>
<td>01345216</td>
</tr>
<tr>
<td>01345406</td>
</tr>
<tr>
<td>01347204</td>
</tr>
<tr>
<td>01345218</td>
</tr>
<tr>
<td>01345217</td>
</tr>
</tbody>
</table>

16
<table>
<thead>
<tr>
<th>Obsid</th>
<th>Target</th>
<th>Rev</th>
<th>CP07</th>
<th>GR12</th>
<th>GR12v</th>
<th>nl</th>
</tr>
</thead>
<tbody>
<tr>
<td>01345220</td>
<td>AB Dor</td>
<td>546</td>
<td>-0.5</td>
<td>3.0±1.7 (2.1)</td>
<td>1.7±1.7 (1.9)</td>
<td>2</td>
</tr>
<tr>
<td>01345221</td>
<td>AB Dor</td>
<td>560</td>
<td>2.6</td>
<td>2.4±0.9 (0.4)</td>
<td>1.0±0.9 (0.4)</td>
<td>3</td>
</tr>
<tr>
<td>01345222</td>
<td>AB Dor</td>
<td>572</td>
<td>6.8</td>
<td>5.4±1.1 (1.7)</td>
<td>4.1±1.1 (1.5)</td>
<td>2</td>
</tr>
<tr>
<td>01345223</td>
<td>AB Dor</td>
<td>605</td>
<td>7.8</td>
<td>7.9±0.9 (5.1)</td>
<td>6.6±0.9 (5.2)</td>
<td>3</td>
</tr>
<tr>
<td>01345224</td>
<td>AB Dor</td>
<td>636</td>
<td>8.5</td>
<td>10.7±1.7 (2.4)</td>
<td>9.5±1.7 (2.6)</td>
<td>2</td>
</tr>
<tr>
<td>01603625</td>
<td>AB Dor</td>
<td>668</td>
<td></td>
<td>5.0±2.0 (0.8)</td>
<td>3.8±2.0 (0.6)</td>
<td>2</td>
</tr>
<tr>
<td>01603626</td>
<td>AB Dor</td>
<td>668</td>
<td>9.0</td>
<td>9.0±1.4 (1.4)</td>
<td>7.8±1.4 (1.6)</td>
<td>3</td>
</tr>
<tr>
<td>01603627</td>
<td>AB Dor</td>
<td>709</td>
<td>4.4</td>
<td>3.0±1.6 (0.3)</td>
<td>1.7±1.6 (0.1)</td>
<td>2</td>
</tr>
<tr>
<td>01603628</td>
<td>AB Dor</td>
<td>732</td>
<td>2.0</td>
<td>2.4±0.9 (2.9)</td>
<td>1.1±0.9 (3.1)</td>
<td>3</td>
</tr>
<tr>
<td>01345407</td>
<td>HR 1099</td>
<td>766</td>
<td></td>
<td>5.5±0.9 (4.9)</td>
<td>4.9±0.9 (5.0)</td>
<td>3</td>
</tr>
<tr>
<td>01347208</td>
<td>Capella</td>
<td>790</td>
<td>10.7</td>
<td>12.2±0.4 (1.8)</td>
<td>9.5±0.4 (1.4)</td>
<td>3</td>
</tr>
<tr>
<td>01345408</td>
<td>HR 1099</td>
<td>857</td>
<td>5.7</td>
<td>6.1±0.8 (4.1)</td>
<td>7.9±0.8 (3.8)</td>
<td>2</td>
</tr>
<tr>
<td>01347215</td>
<td>Capella</td>
<td>871</td>
<td>5.0</td>
<td>6.9±0.4 (1.4)</td>
<td>6.9±0.4 (1.4)</td>
<td>4</td>
</tr>
<tr>
<td>01345409</td>
<td>HR 1099</td>
<td>942</td>
<td>-1.6</td>
<td>-0.7±0.7 (3.1)</td>
<td>-1.2±0.7 (3.1)</td>
<td>4</td>
</tr>
<tr>
<td>01347216</td>
<td>Capella</td>
<td>971</td>
<td>11.8</td>
<td>12.2±0.7 (2.6)</td>
<td>9.5±0.7 (2.7)</td>
<td>3</td>
</tr>
<tr>
<td>01347217</td>
<td>Capella</td>
<td>972</td>
<td>11.8</td>
<td>12.3±0.8 (2.2)</td>
<td>9.6±0.8 (2.3)</td>
<td>3</td>
</tr>
<tr>
<td>01603630</td>
<td>AB Dor</td>
<td>981</td>
<td>8.2</td>
<td>8.3±1.1 (5.0)</td>
<td>7.0±1.1 (5.2)</td>
<td>3</td>
</tr>
<tr>
<td>01603632</td>
<td>AB Dor</td>
<td>1072</td>
<td>8.1</td>
<td>5.8±1.0 (0.5)</td>
<td>4.5±1.0 (0.4)</td>
<td>3</td>
</tr>
<tr>
<td>01347220</td>
<td>Capella</td>
<td>1150</td>
<td>9.3</td>
<td>9.8±0.4 (1.3)</td>
<td>7.1±0.4 (1.3)</td>
<td>3</td>
</tr>
<tr>
<td>04125801</td>
<td>AB Dor</td>
<td>1293</td>
<td>0.1</td>
<td>0.5±1.1 (2.4)</td>
<td>-0.8±1.1 (2.2)</td>
<td>2</td>
</tr>
<tr>
<td>01347221</td>
<td>Capella</td>
<td>1319</td>
<td>-3.4</td>
<td>-2.5±0.4 (2.1)</td>
<td>-5.2±0.4 (1.6)</td>
<td>4</td>
</tr>
<tr>
<td>04125802</td>
<td>AB Dor</td>
<td>1393</td>
<td></td>
<td>7.0±1.1 (2.1)</td>
<td>5.8±1.1 (1.9)</td>
<td>2</td>
</tr>
<tr>
<td>05107801</td>
<td>Capella</td>
<td>1413</td>
<td>9.5</td>
<td>11.2±0.4 (5.5)</td>
<td>11.1±0.4 (5.5)</td>
<td>4</td>
</tr>
<tr>
<td>04125803</td>
<td>AB Dor</td>
<td>1478</td>
<td></td>
<td>1.0±1.1 (1.2)</td>
<td>-0.4±1.1 (0.9)</td>
<td>3</td>
</tr>
<tr>
<td>05107802</td>
<td>Capella</td>
<td>1607</td>
<td></td>
<td>3.4±0.5 (3.3)</td>
<td>3.3±0.5 (3.3)</td>
<td>4</td>
</tr>
<tr>
<td>04125804</td>
<td>AB Dor</td>
<td>1662</td>
<td></td>
<td>2.1±1.1 (1.0)</td>
<td>0.8±1.1 (3.3)</td>
<td>3</td>
</tr>
<tr>
<td>05107804</td>
<td>Capella</td>
<td>1796</td>
<td></td>
<td>-0.0±0.5 (3.6)</td>
<td>-0.2±0.5 (3.5)</td>
<td>4</td>
</tr>
<tr>
<td>04125806</td>
<td>AB Dor</td>
<td>1848</td>
<td></td>
<td>2.7±1.2 (0.6)</td>
<td>1.4±1.2 (0.8)</td>
<td>3</td>
</tr>
<tr>
<td>05107805</td>
<td>Capella</td>
<td>1961</td>
<td></td>
<td>9.8±0.5 (1.8)</td>
<td>9.6±0.5 (1.8)</td>
<td>3</td>
</tr>
</tbody>
</table>

shifts in mÅ, given as average±error (rms)

nl: number of lines measured in the spectrum.
CP07: Data from Coia and Pollock 2007.
GR12: This work without velocity correction.
GR12v: This work, with star+barycenter velocity correction.
Figure 8: As Fig. 6 for RGS1 Order 2.

Figure 9: As Fig. 6 for RGS2 Order 2.