Doppler Shift Calculations

Name:

Date:

Given information:

Speed of light = c = $3x10^5$ km/s

NaD line 1 (λ_1) = 5889.96 Angstroms

NaD line 2 (λ_2) = 5895.93 Angstroms

$\Delta\lambda_{Line\ 1-2} = \lambda_2 - \lambda_1$ = 5.97 Angstroms (used for conversion)

In the Excel template, determine the line minimums for the two lines (i.e. Left and Right or TopLeft and BottomLeft, etc.) with the largest shift. Below we call the two lines P1 (stands for "position 1 (on the solar disk)") and P2.

Measurements from Excel Template:

$Pix_{NaD\_Line1@P1}$ = ____________________ (in pixels)

$Pix_{NaD\_Line1@P2}$ = ____________________ (in pixels)

$Pix_{NaD\_Line2@P1}$ = ____________________ (in pixels)

$Pix_{NaD\_Line2@P2}$ = ____________________ (in pixels)

$Pix_{WaterLine@P1}$ = ____________________ (in pixels)

$Pix_{WaterLine@P2}$ = ____________________ (in pixels)

Calculations:

<u>Conversion factor from pixel to wavelength</u>

Calculate the pixel separation between NaD line 1 and NaD line 2 for each solar disk positions. These should be the same value.

Position 1: $\Delta pixel_{Line\ 1-2}$ = ____________________

Position 2: $\Delta pixel_{Line\ 1-2}$ = ____________________

$\Delta\lambda_{conversion} = \Delta\lambda_{Line\ 1-2} / \Delta pixel_{Line\ 1-2}$ = ____________________

Doppler Shift

Apparent pixel shift in sodium lines:

$\Delta Pix_{Line1,\ apparent} = Pix_{NaD\_Line1@P1} - Pix_{NaD\_Line1@P2}$ = _______________ (in pixels)

$\Delta Pix_{Line2,\ apparent} = Pix_{NaD\_Line2@P1} - Pix_{NaD\_Line2@P2}$ = _______________ (in pixels)

Correction factor determined from apparent water line offset:

$\Delta Pix_{correction} = Pix_{WaterLine@P1} - Pix_{WaterLine@P2}$ = _______________ (in pixels)

True pixel shift in sodium lines:

$\Delta Pix_{Line1,\ true} = \Delta Pix_{Line1,\ apparent} - \Delta Pix_{correction}$ = _______________ (in pixels)

$\Delta Pix_{Line2,\ true} = \Delta Pix_{Line2,\ apparent} - \Delta Pix_{correction}$ = _______________ (in pixels)

True wavelength shift in sodium lines:

$\Delta\lambda_{Line1} = \Delta Pix_{Line1,\ true}$ (in pixels) * $\Delta\lambda_{conversion}$ = __________________ (in Angstroms)

$\Delta\lambda_{Line2} = \Delta Pix_{Line2,\ true}$ (in pixels) * $\Delta\lambda_{conversion}$ = __________________ (in Angstroms)

Rotational Velocity

Solve for ΔV, which is the difference of velocities at positions 1 and 2, using $\Delta V/c = \Delta\lambda/\lambda_{Line\ 1}$. The solar rotational velocity itself would then be the absolute value of ($\Delta V/2$). Fill in the table below with actual numbers:

Na D Line number	$\Delta\lambda$ (in Angstroms)	ΔV (in km/s)	$V_{rotation}$ (in km/s)
1	$\Delta\lambda_{Line1}$		
2	$\Delta\lambda_{Line2}$		
Average	X	X	