The Application of the FPI for Balmer $\alpha$ Studies

Edwin Mierkiewicz
Fred Roesler
Susan Nossal
James Bishop
Ron Reynolds
WH\(\alpha\)M

- 200 km/s
- 4500-9000 Å
- 12 km/s (R~25,000)
- 1° beam

PBO

- 75 km/s
- 4500-9000 Å
- 3.75 km/s (R~80,000)
- 1.5° beam
\textit{hi}: l = 0.149 \text{ cm}; Q\sigma = 3.36 \text{ cm}^{-1} \\
\textit{low}: l = 0.0524 \text{ cm}; Q\sigma = 9.54 \text{ cm}^{-1}
Sample Balmer $\alpha$ (656.3 nm) spectrum and 9-component Gaussian fit

- line center
- line width
- area under the line
- bin number (where 1 bin = 0.75 km/s)

Cascade

Solar Lyman $\beta$ excitation
Reynolds et al.

Geocoronal

ISM

Wisconsin H–Alpha Mapper Northern Sky Survey
Total Integrated Intensity Map (−80 < v_{LSR} < +80 km s⁻¹)

t = 120°

δ = 30°
δ = 10°

Log Intensity [Rayleighs]

< −0.50 −0.25 0.00 0.25 0.50 0.75 1.00 1.25 1.50 > 1.75

http://www.astr.wisc.edu/wham/

~3R
Lots of “cascade”

VLSR

bin number (where 1 bin = 0.75 km/s)
Forward model to obtain $[H](z)$ and $\Phi(H)$? See e.g., Bishop et al., 2004
$T_s$ and $n_s$

$n_{exo}$

$\phi(H)$

$n_{\text{max}}$

$\text{Ly } \gamma$

$\text{Ly } \beta$

$\text{Ly } \alpha$

geometric altitude (km)

$[\text{H}]$ number density ($1/\text{cm}^3$)
We are currently focusing on the interpretation of coincident PBO and EURD data obtained in March 2000 with the aide of the radiative transport code lyao_rt [Bishop, 1999; 2001]

The current study aims to map-out bounds for feasible atomic hydrogen density distributions [H](z)

Past work along these lines [Bishop, 1991; 2001; Bishop et al, 2001] sought to define parameters - the exobase density $n_{exo}$, the net thermospheric upward flux $\phi$, the mesospheric peak density $n_{max}$, and the satellite population parameters $T_s$ and $n_s$ - suitable for such analyses, and to assess the degree to which these parameters might be constrained

The March 2000 data allows us to carry out a preliminary search for such bounds
Our adopted set of parameter values is rather crude, but sufficient to determine parameter ranges that yield “good fits” to both the PBO and EURD measurements

**The range of model parameters used in our search**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n_{exo}$</td>
<td>2, 4, 5.7, 8, 11.3, 16 x 10^4 cm⁻³</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.3, 1, 3, 9 x 10^8 cm⁻² s⁻¹</td>
</tr>
<tr>
<td>$n_{\text{max}}$</td>
<td>0.3, 1, 3, 9 x 10^8 cm⁻³</td>
</tr>
<tr>
<td>$T_s/n_s$</td>
<td>450/3(7), 600/2.2(6), 750/5(5), 1100/7.4(4) K/cm⁻³</td>
</tr>
<tr>
<td>$f(n_s)$</td>
<td>0.73, 1.0, 1.36</td>
</tr>
<tr>
<td>$f(F_{10.7})$</td>
<td>0.85, 1.0, 1.15</td>
</tr>
</tbody>
</table>
Our preliminary search requires:

1) EURD-derived solar line-center fluxes for the two hemispheres agree to within 10%

2) that these fluxes are in the range 5-20 * 10^9 cm\(^{-2}\) s\(^{-1}\)

3) that the corresponding fluxes derived from the PBO Balmer $\alpha$ data agree with the EURD-derived fluxes to within ~50% (to allow for some variation in $n_{exo}$ near the terminators as seen by PBO but not by EURD), and

4) data/model ratios for the PBO intensity variations with shadow altitude are in the range 0.9-1.1 at shadow heights 500 km and 5000 km.
Present/Future

- Line profiles Hα/Hβ
- Intensity Hα/Hβ
- Cascade at Hα
- Forward-model retrieval of H(z), φ(z)