Resonant Scattering of OII 83.4 nm

- Produced by transition $O^+ (3P^o) \rightarrow O^+ (3P^o)$
- Brightest EUV airglow feature [Chakrabarti et al. 1983]
- Production peaks at 150-175 km [Kumar et al. 1983]
- Resonantly scattered off of ground state $O^+$
- Optical depths typically $1 < \tau < 10$

![Photoionization](image)

It is possible to invert intensity profiles of OII 83.4 nm to obtain the underlying $O^+$ density [McCoy et al. 1985; Douglas et al. 2012]. Next generation EUV remote sensing missions will need to perform this inversion procedure on large data sets. A computationally efficient forward model is integral to an efficient inversion algorithm.

Feautrier Solution
Differential equation approach based on two-stream and radiative diffusion approximations [Mihalas 1978]
1. Change variables to intensity-like $u$ and flux-like $v$
   $$ u = \frac{1}{2} [I(\tau_v, \mu) + I(\tau_v, -\mu)] $$
   $$ v = \frac{1}{2} [I(\tau_v, \mu) - I(\tau_v, -\mu)] $$
2. Use the radiative transport equation to obtain two ODEs
3. Make the radiative diffusion approximation at the boundary
4. Solve via finite difference
5. Iterate until solution converges

Markov Chain Solution
Statistical approach based on random walks of photons [Esposito and House 1978; Vickers 1996]
1. Divide atmosphere into finite cells
2. Construct single scattering matrix, $Q$
3. Compute multiple scattering matrix, $M = (1 - Q)^{-1}$
4. Apply multiple scattering matrix to initial source

$$ S_f = S_0 + Q S_0 + Q^2 S_0 + Q^3 S_0 + \cdots $$
$$ = (1 - Q)^{-1} S_0 $$

Finch-imaging Ionospheric and Thermospheric EUV Spectrograph (FITES)
FITES is a high-resolution EUV spectrograph with the ability to measure OII 83.4 nm and OI 130.4 nm simultaneously. The EUV and ion纪委 complete observation cycle as a priority for this mission. FITES will begin observing from the International Space Station in 2026.

Acknowledgements
Feautrier model results were generated by WINTRAN by Computational Physics Inc. Data for the Markov chain model results were provided by P. Wood and B. D. Wood through the NASA's High-Resolution Solar Spectral Irradiance Model (HSSM) and the University of Delaware's Optical-Thermal Analytical Code (ALOCA).