Problem 3: Strömgren sphere (photochemistry)

Part1: photoionization vs recombination

$$H + \gamma \rightarrow H^+ + e^- \tag{1}$$
$$H^+ + e^- \rightarrow H + \gamma \tag{2}$$
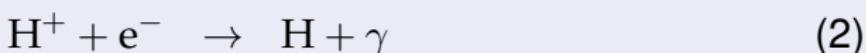
- wrap photoreactions into
  @photo_start
  @photo_stop
- standard reactions use rates $k(\text{Tgas})$
- photoreactions use cross sections $\sigma(\text{energy\_eV})$
- easier than expected: just use *auto*
- TODO: prepare chemical network

Part2: KROME preprocessor (aka Python)

- use the two-reactions chemical network
- `–photoBins=1`
- TODO: run pre-processor

Part3: pseudocode
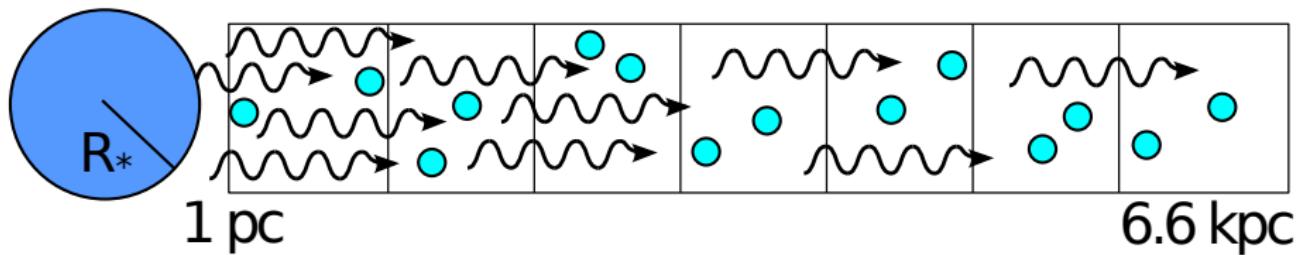
- https://bitbucket.org/tgrassi/krome-exercises-2015
- `git pull origin`
- sketch for `test.f90` is provided (replace autogenerated)
- 1-zone problem: `xall(GRID_POINTS, NUMBER_OF_SPECIES)`
- TODO: complete the code using the pseudocode on the text

```
dt = 0.1 yr
LOOP time
 dt = dt * 1.01
 t = t + dt
 LOOP grid for i
  x(:) = xall(i,:)
  call KROME(x(:),Tgas,dt)
  xall(i,:) = x(:)
 END LOOP grid
 if(t>tmax) break loop on time
END LOOP time
```

Part4: geometrical attenuation

- `krome_set_photoBin_BBlog(...)`
- `krome_photoBin_scale(...)`
- `krome_photoBin_restore(...)`
- TODO: add geometrical attenuation

```
<<<<<<-----INIT BB RADIATION
dt = 0.1 yr
LOOP time
 dt = dt * 1.01
 t = t + dt
 LOOP grid for i
  <<<<<<-----RESTORE FLUX
  <<<<<<-----SCALE BB RADIATION (geometric, eta_g)
  x(:) = xall(i,:)
  call KROME(x(:),Tgas,dt)
  xall(i,:) = x(:)
 END LOOP grid
 if(t>tmax) break loop on time
END LOOP time
```

Part4/2: geometrical factor

- $\eta_g^{th} = 4\pi^2 R_\star^2/(4\pi r^2)$
- $\eta_g^{krome} = \eta_g^{th}/(4\pi) = \pi R_\star^2/(4\pi r^2) = R_\star^2/(4r^2)$
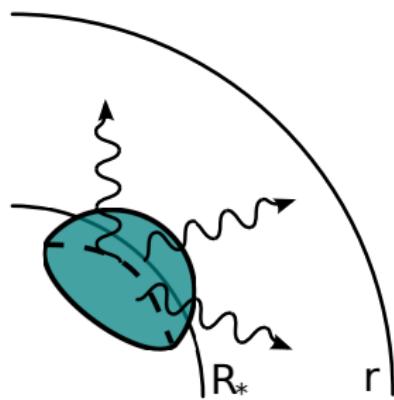
KROME Bootcamp 2014 - Optically <u>thick</u> case

Part5: opacity attenuation

- `krome_photoBin_scale_array(...)` (note: `array`)
- $\eta_i(E) = \prod_{j=0}^{i} \exp[-\tau_i(E)]$
- TODO: add opacity attenuation

```
<<<<<<-----INIT BB RADIATION
dt = 0.1 yr
LOOP time
 dt = dt * 1.01
 t = t + dt
 LOOP grid for i
  <<<<<<-----RESTORE FLUX
  <<<<<<-----GET OPACITY
  <<<<<<-----COMPUTE eta_i PRODUCT
  <<<<<<-----SCALE BB RADIATION (eta_g*eta_i)
  x(:) = xall(i,:)
  call KROME(x(:),Tgas,dt)
  xall(i,:) = x(:)
 END LOOP grid
 if(t>tmax) break loop on time
```

GOOD WORK!