# Single Dish Radio Observation

Visualization of the map data with the moment 0 and moment 1 maps

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## What is the map data?

- Open the map data using GILDAS/CLASS
- Orion\_13CO\_baseline\_subtracted.class from Singledish\_clss3

```
LAS> file in Orion_13CO_baseline_subtracted.class
```

LAS> set unit v f

LAS> find

LAS> set mode x 25 -5

LAS> set mode y -1 12

LAS> map /num /grid

#### How can we visualize the data?

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## Github repository, Singledish\_class5

HyeongSikYun/Singledish\_class5 (github.com)

```
    Orion_13CO_baseline_subtracted.class
    Orion_13CO_baseline_subtracted.fits
```

Singledish\_class.py

## Singledish\_class.class

1. hdu = read\_fits('/path/to/file/','name\_of\_fits\_file.fits')

2. what\_do\_you\_want\_to\_see(velo,spec)

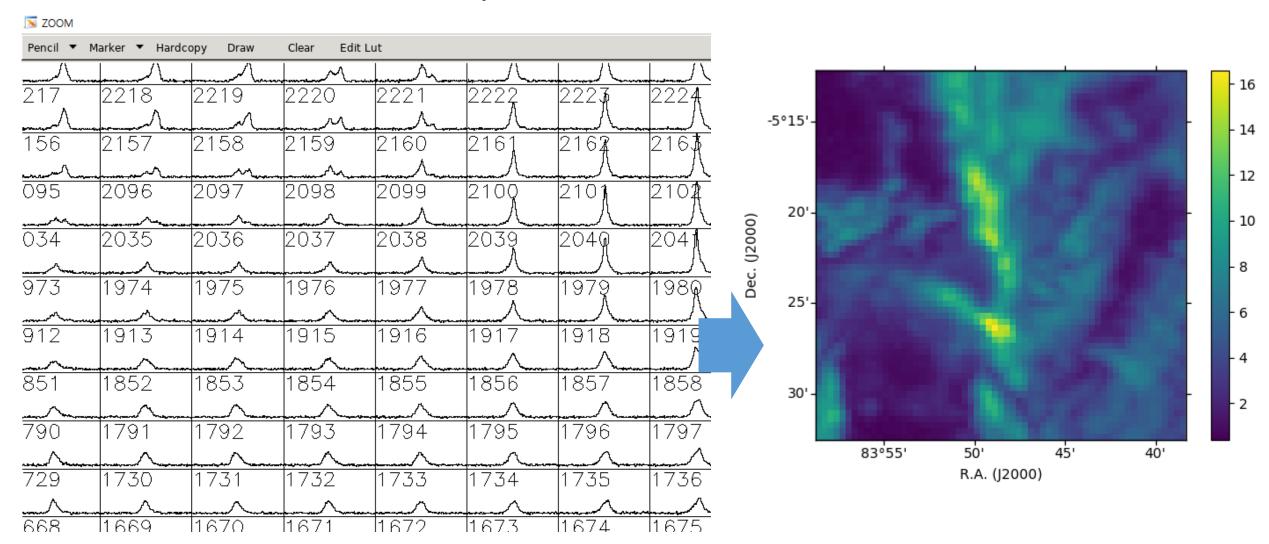
3. produce\_map\_fig(hdu)



Modify it to produce other maps

sub-routine 'produce\_map\_fig' initially produces the peak temperature map

## Test run (the T<sub>peak</sub> map)



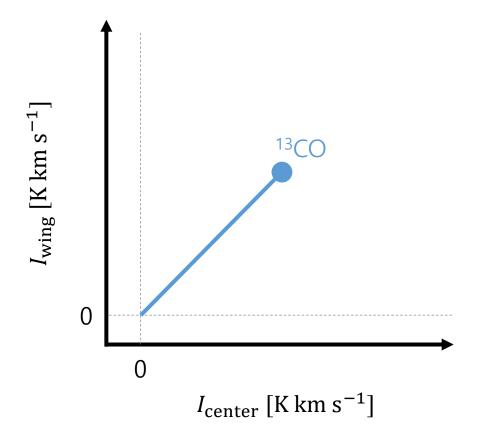
### From singledish\_class4...

Integrated intensities of each components

• 
$$I_{\text{center}} = \int_5^{13} T(v) dv$$

• 
$$I_{\text{wing}} = \int_{-11}^{5} T(v) dv + \int_{13}^{29} T(v) dv$$

• Integration over a given velocity range.



## Total line intensity emitted from each pixel

Integrate over the whole velocity range

-> integrated intensity
$$\int_{v_1}^{v_2} T(v) \cdot dv$$

We cannot obtain the continuous data.

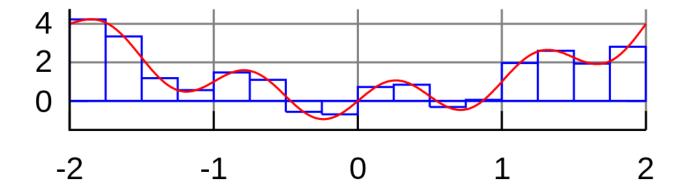
T(v) contains intensities (T) at regularly spaced velocities (v). All the data are discrete!!

## Integration in discrete data (numerical integration)

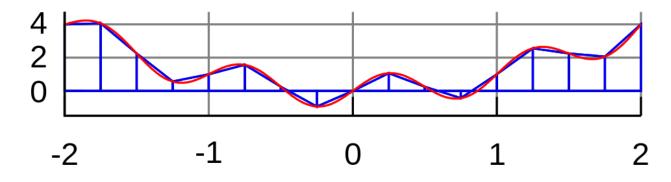
#### Rectangule rule

$$\int_{v_1}^{v_2} T(v) \cdot dv = \sum_{v_1}^{v_2} T(v) \cdot \Delta v$$

[ $\Delta v$ : a velocity channel width]



- More fancy methods of integration are as follows,
  - Trapezoidal rule, Simpson's rule, ...



## Integration in discrete data (numerical integration)

#### Rectangule rule

$$\int_{v_1}^{v_2} T(v) \cdot dv = \sum_{v_1}^{v_2} T(v) \cdot \Delta v \qquad >>> \text{dv = velo[1] - velo[0]}$$

$$= \Delta v \cdot \sum_{v_1}^{v_2} T(v)$$

$$= \Delta v \cdot \sum_{v_1}^{v_2} T(v)$$

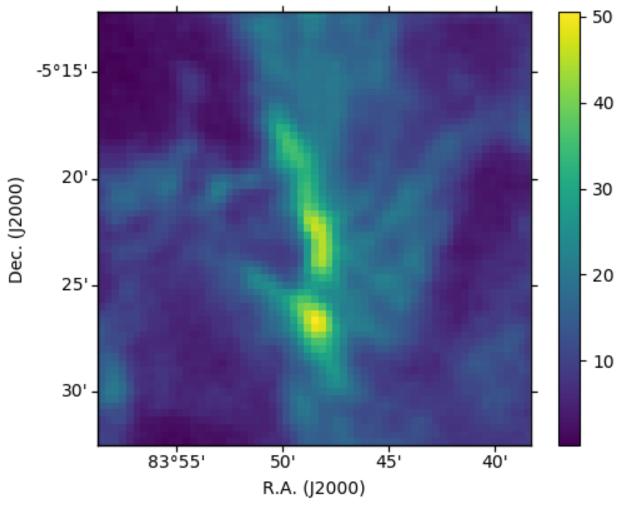
[If  $\Delta v$  is constant;  $\Delta v$ : a velocity channel width]

### Exercise: Integrated intensity map

Modify a function,
 'what\_do\_you\_want\_to\_see' in
 'singledish\_class.py'.

Use a following command

>>> produce\_map\_fig(hdu)



## Intensity weighted velocity map

Moment 1 map

moment 1 = 
$$\frac{\sum_{v_1}^{v_2} T(v) \cdot v}{\sum_{v_1}^{v_2} T(v)}$$

 Similar to the expected value of a given probability distribution function.

$$E[X] = \int\limits_R x \cdot f(x) \ dx$$

## Exercise: intensity weighted velocity map

moment 1 = 
$$\frac{\sum_{v_1}^{v_2} T(v) \cdot v}{\sum_{v_1}^{v_2} T(v)}$$

- Modify a function, 'what\_do\_you\_want\_to\_see' in 'singledish\_class.py'.
- Use a following command
- >>> produce\_map\_fig(hdu)

Exercise: intensity weighted velocity

map

moment 1 = 
$$\frac{\sum_{v_1}^{v_2} T(v) \cdot v}{\sum_{v_1}^{v_2} T(v)}$$

$$\begin{array}{c} 20^{\circ} \\ \hline \\ 25^{\circ} \\ \hline \end{array}$$

$$\begin{array}{c} 20^{\circ} \\ \hline \\ 30^{\circ} \\ \hline \end{array}$$

$$\begin{array}{c} 30^{\circ} \\ \hline \\ 83^{\circ}55^{\circ} \\ \hline \end{array}$$

$$\begin{array}{c} 50^{\circ} \\ \hline \\ 83^{\circ}55^{\circ} \\ \hline \end{array}$$