

Kpc scale AgN
and
Stellar disk



3

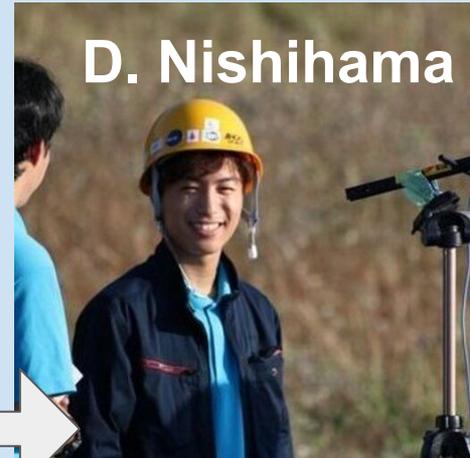
KANSAI area



S. Inoue



M. Yamashita



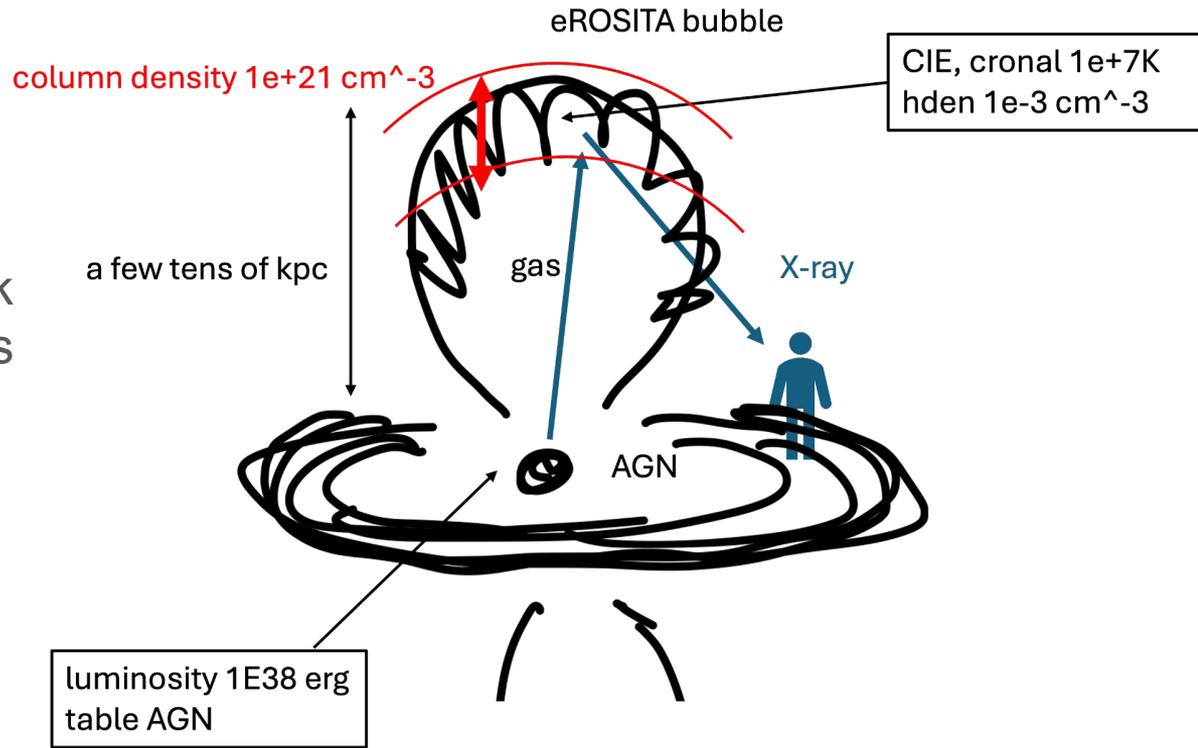
D. Nishihama

Introduction & Calculation Model

To simplify, I created the following model↓

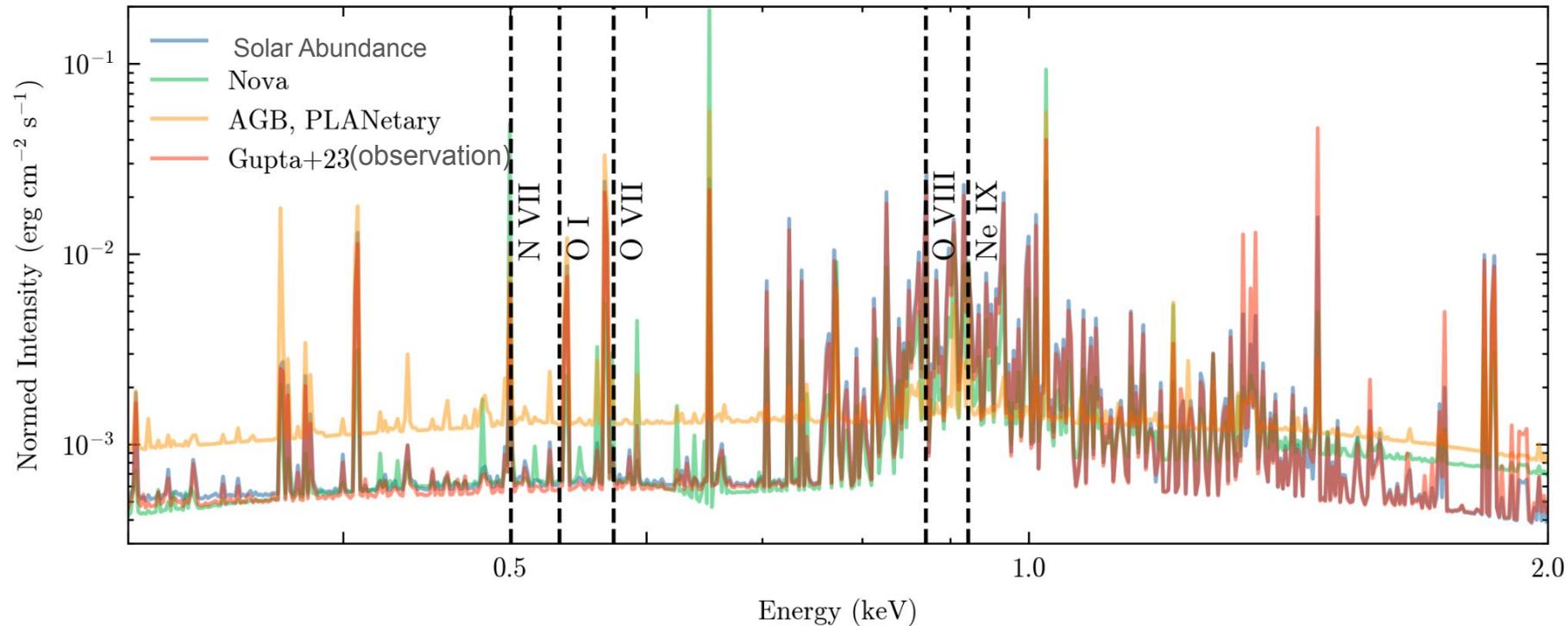
My goal

to create a simplified model of the eROSITA bubble, look at the spectra due to various abundances and hydrogen densities, and compare them with the Gupta paper observed by the Suzaku telescope.

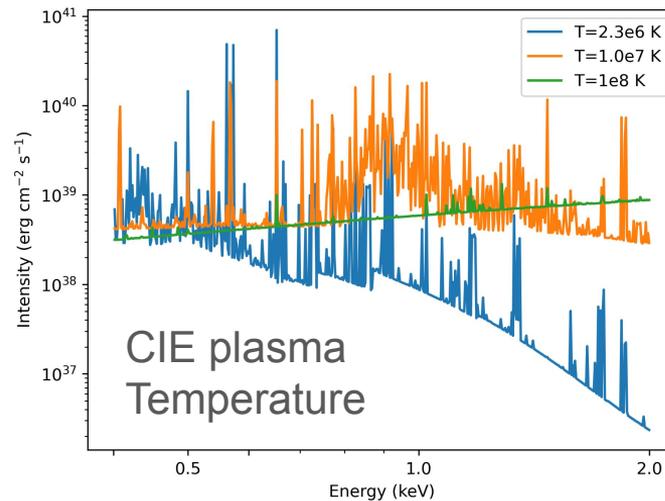
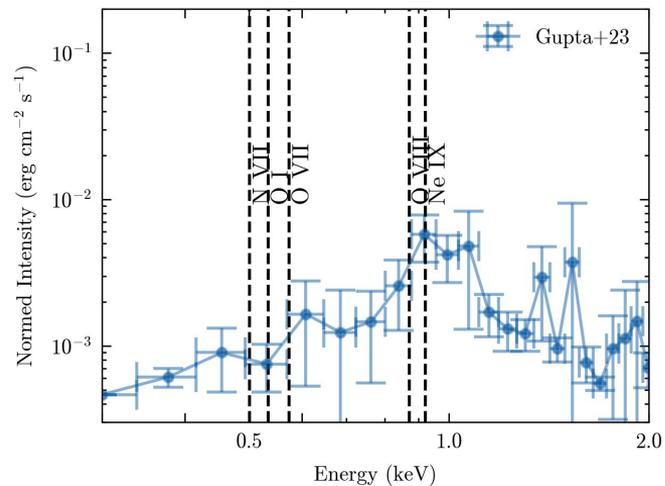
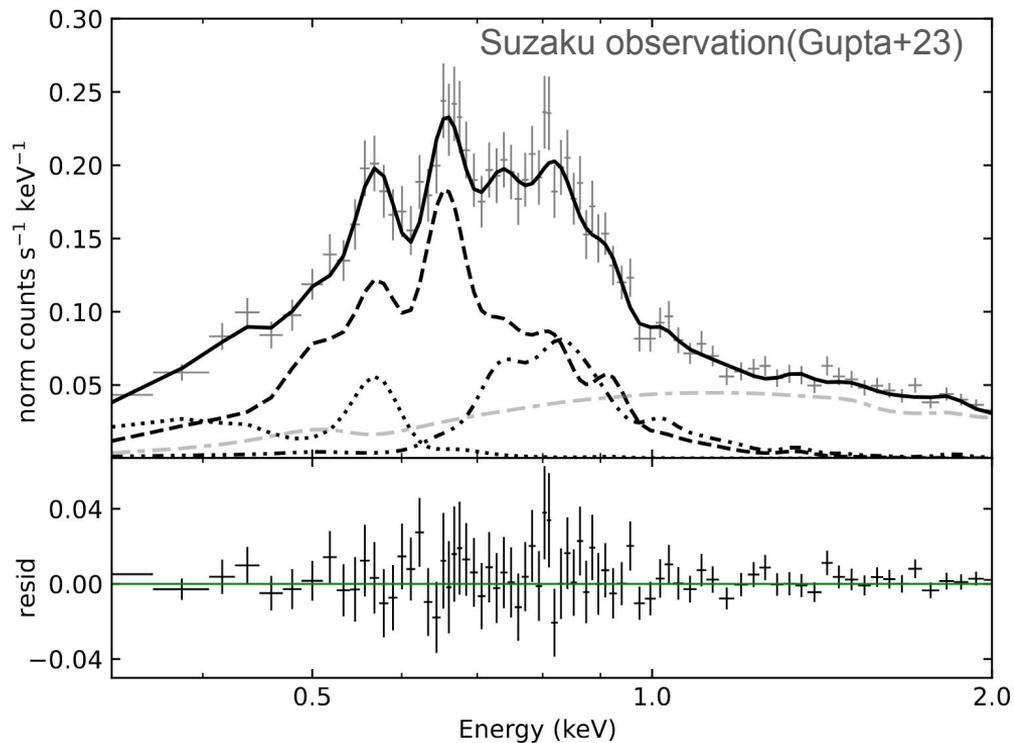


Projected Milky Way galaxy with edge on

Result with various abundances

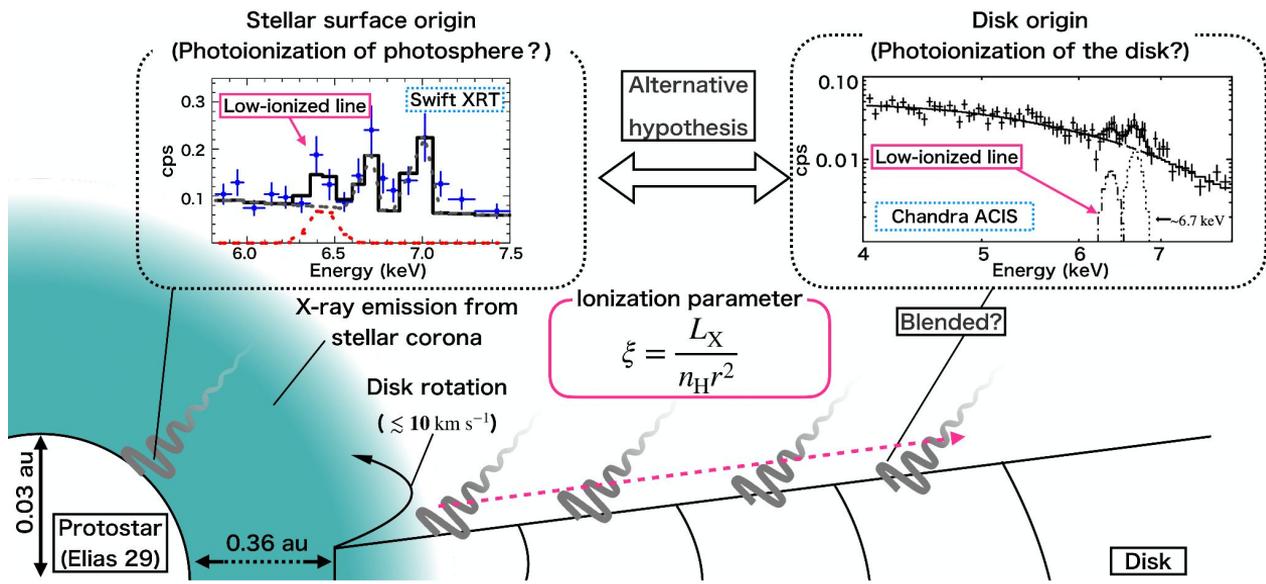


Discussion & Summary



Introduction: Fe K α line on Pre-main sequence stars

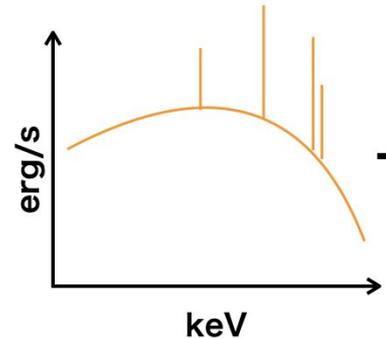
- The low-ionized Fe K α line (~6.4 keV) is sometimes observed during flares on pre-main sequence stars (e.g., Imanishi+2001, Tsujimoto+2005, Favata+2005).
- The line has been considered to be emitted from the photoionized disk.
- We calculated the photoionized flux of the line using Cloudy for the future observation.



Method: Making the coronal spectrum and insert it to disk

Coronal spectrum
 Coronal 10^8 K
 Sphere
 hden 10^{12}

output



input

Corona + Disk spectrum
 table read file
 cylinder h (r)
 hden $n_H(r)$
 radius r_{in}, r_{out}

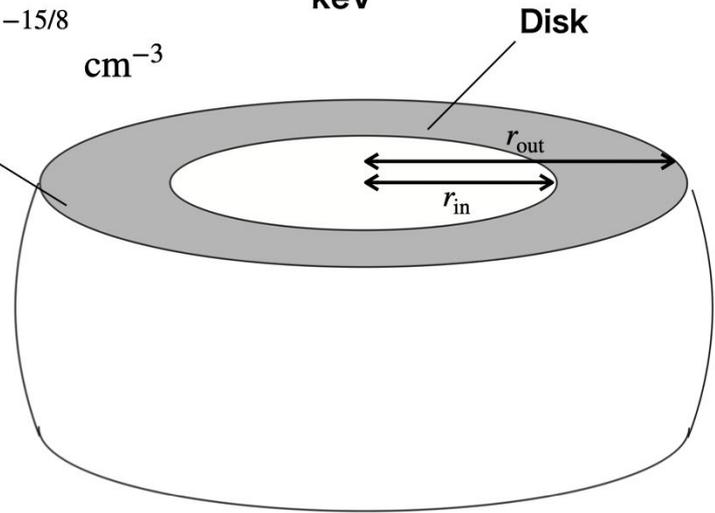
output

?

$$n_H(r) = 6 \times 10^{15} \left(\frac{r}{0.014 \text{ AU}} \right)^{-15/8} \text{ cm}^{-3}$$

(Castro+2024)

$0.3 \text{ au} < r < 9 \text{ au}$

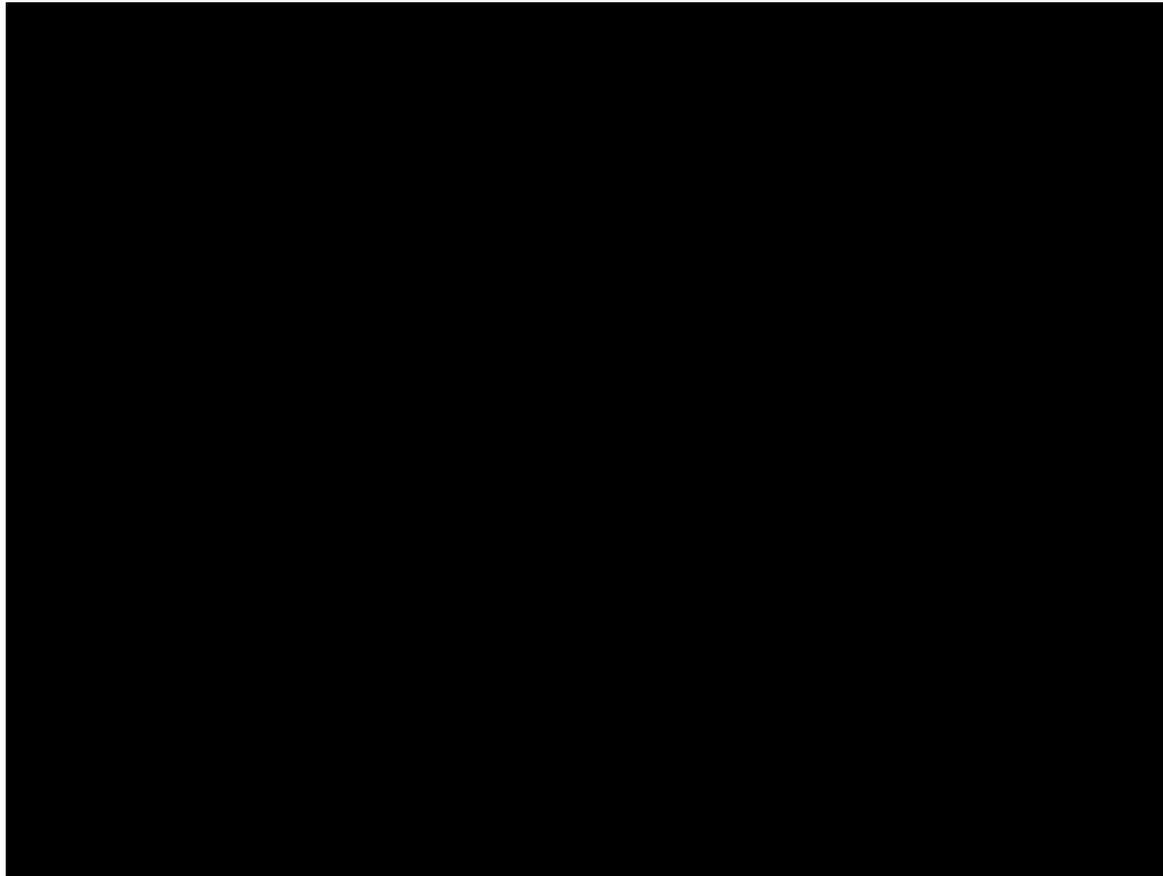


$$h(r) = 0.047 \left(\frac{r}{1 \text{ AU}} \right)^{5/4}$$

From hazy 1

Results & Summary: the variation of the Fe K α line with radius

- The low-ionized Fe K α line (~6.4 keV) should be emitted from the inner edge ($\lesssim 5$ au) of the disk.
- I will also calculate the photoionized flux during the quiescent phase.
- Elias 29 (Class I protostar) will be observed by XRISM in the near future!



Introduction: Active atmosphere of young stars

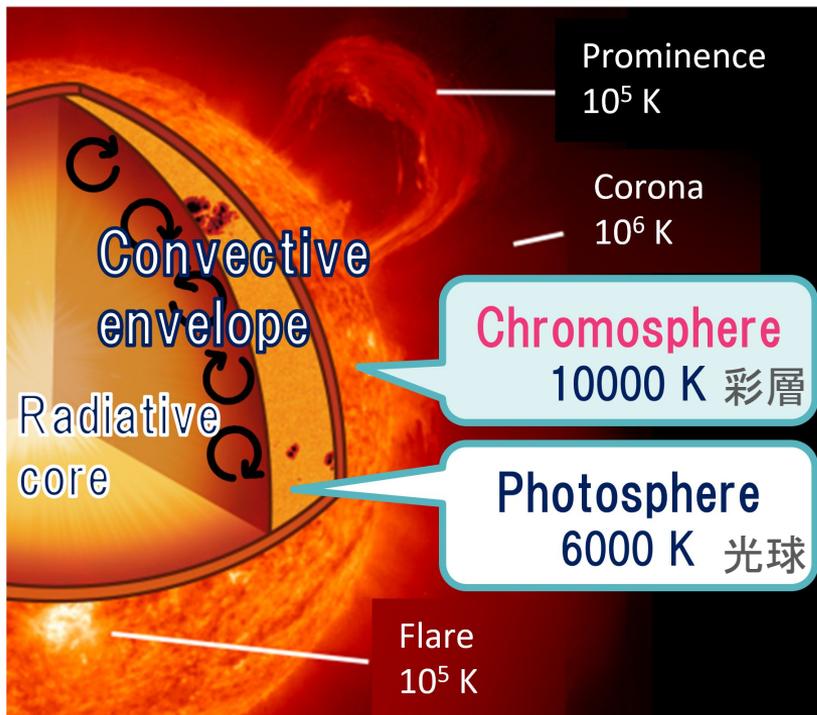


Fig. 1: Structure of a solar-type star (ISAS, NAOJ)

At first, I studied the optical emission lines from the disk of a pre-main-sequence star like Inoue-san, but these lines were weak than expected. Then I studied another region:

Chromosphere is active atmosphere between photosphere and corona (Fig. 1), which produces **bright emission lines such as Ca II**.

Pre-main-sequence stars (young; $10^6 - 10^7$ yr, 前主系列星) also have chromosphere, but the temperature structure are not examined in detail.

I try to investigate the relationship between the chromosphere temperature structure and the evolution of the young stars.

Method: Modeling with CLOUDY

With reference to Batalha & Basri (1993), I constructed very simple models of chromosphere by using CLOUDY.

- Sphere
- Typical Hydrogen density ($10^{17} - 10^{23} \text{ cm}^{-3}$)
- SED: coronal (10000 - 3000 K)

Model 1, 2, and 3 was successful.

Model 4 did not work.

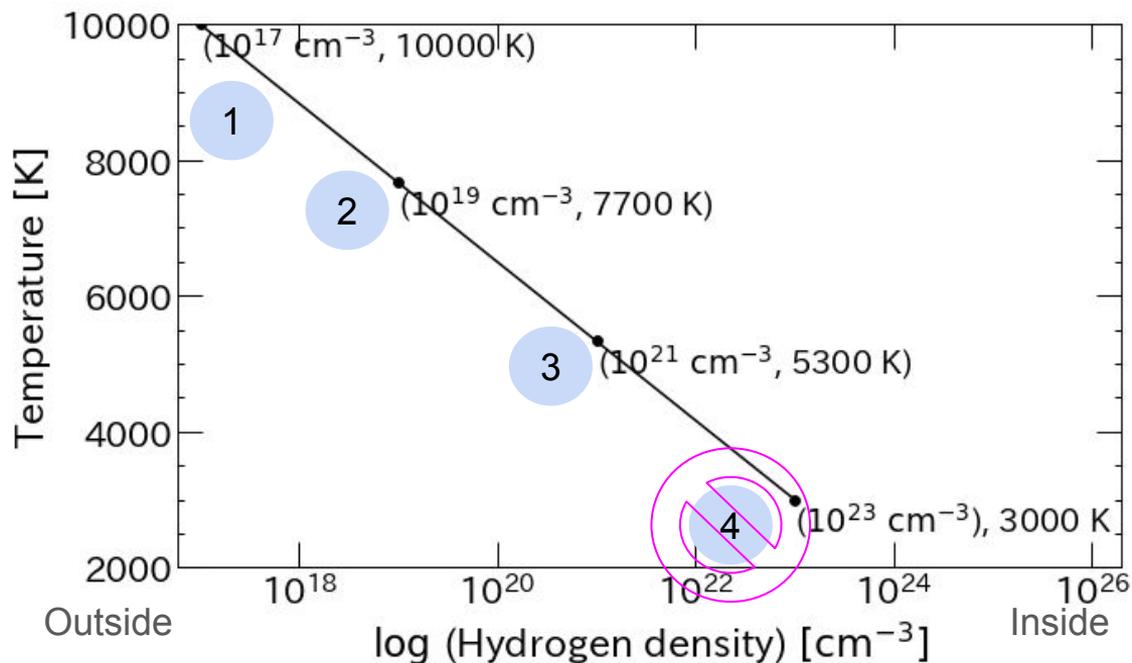


Fig. 2: Setting of the chromospheric model

Result: Strength of Ca II lines

Tab. 1: Overview of Ca II triplet emission lines

	Observations	CLOUDY models
1. 10^{17} cm^{-3} , 10000 K	faint lines	bright lines
2. 10^{19} cm^{-3} , 7700 K	bright lines	bright lines
3. 10^{21} cm^{-3} , 5300 K	brightest lines	no lines

Ionization energy of Ca II is 11.9 eV. The emission lines should be detected in model 2, 3.

Scattering effects in the upper atmosphere, so the emission lines in the model 1 may not be observed. I have no idea about the model 3.

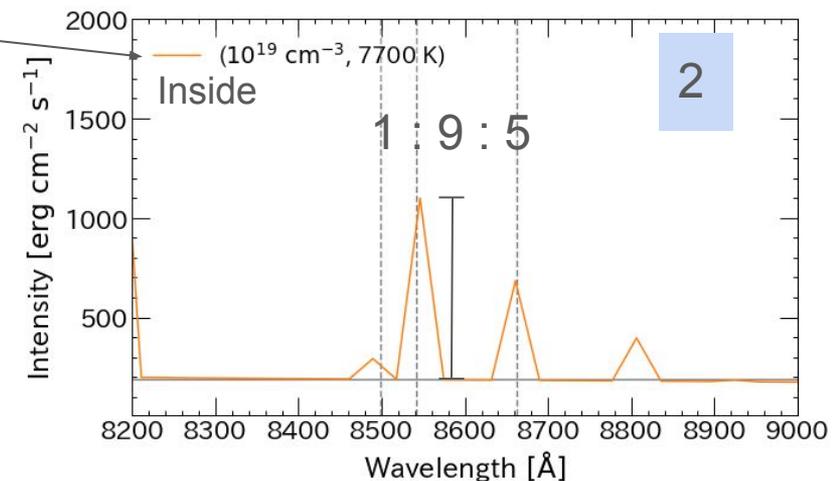
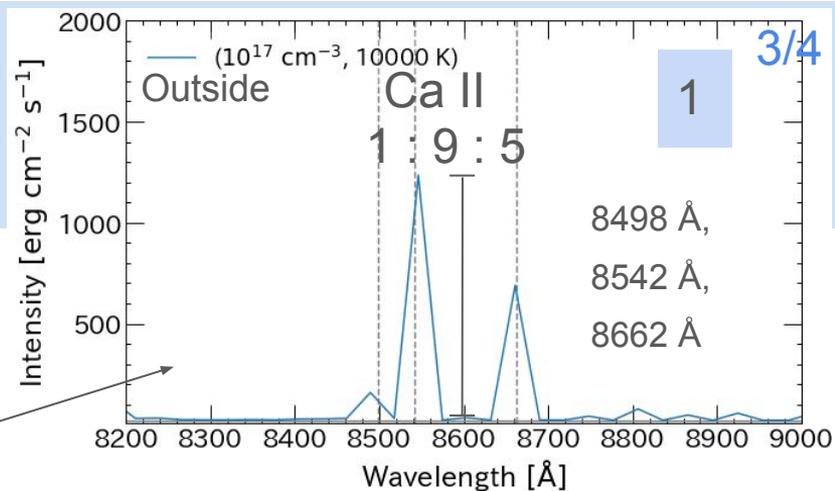


Fig. 3: Model spectra calculated with CLOUDY (near Ca II lines)

Discussion: difference between models and observations

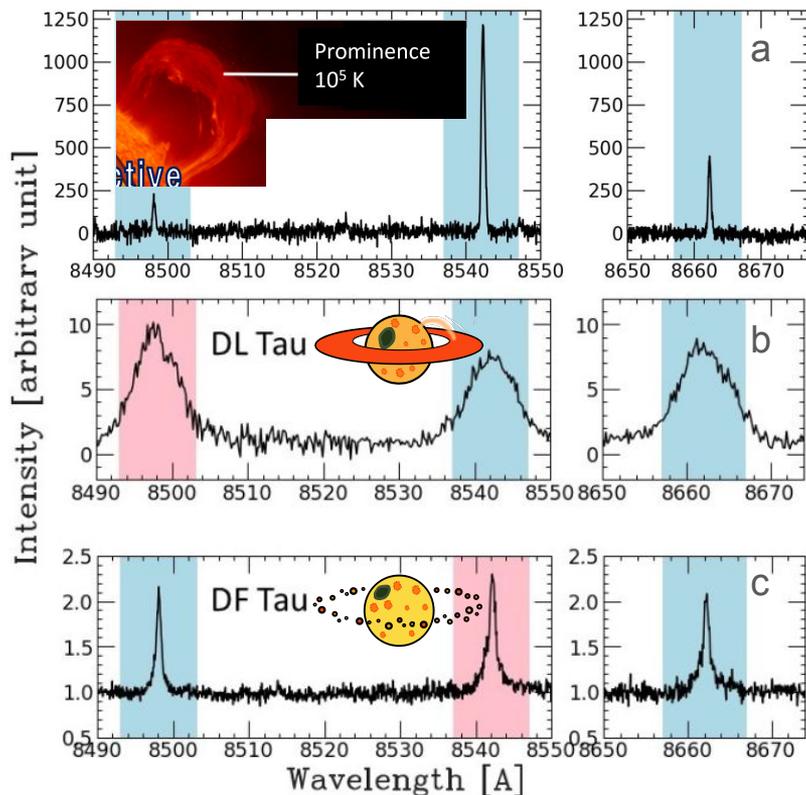


Fig. 4: Observed Ca II emission lines

The line strength ratio (8498 Å : 8542 Å : 8662 Å) of the models was about **1 : 9 : 5**.

It is consistent with the ratio of transition strength (gf values), and the observed emission lines from the solar prominence (Fig. 4a).

It is **NOT** consistent with the observational results of pre-main-sequence stars (Fig. 4b, 4c). Most of them have the line strength ratio equal to each other (**~ 1 : 1.2 : 1.2**). It may result from the shock of mass accretion from the disk.

Kpc scale AgN and Stellar disk

Summary

Nishihama:

- By comparing the various abundances, the spectral peaks were in some agreement. But, there were differences from my results in the rate of decrease at the high energy side.
- Perhaps it was an effect of the Earth's atmosphere or a faulty setting of the plasma temperature.

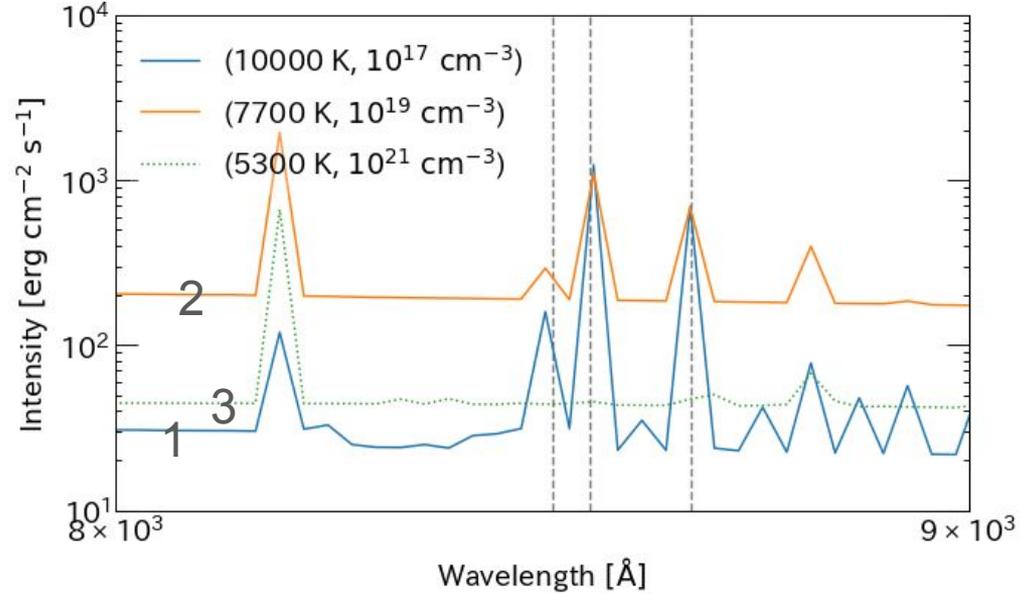
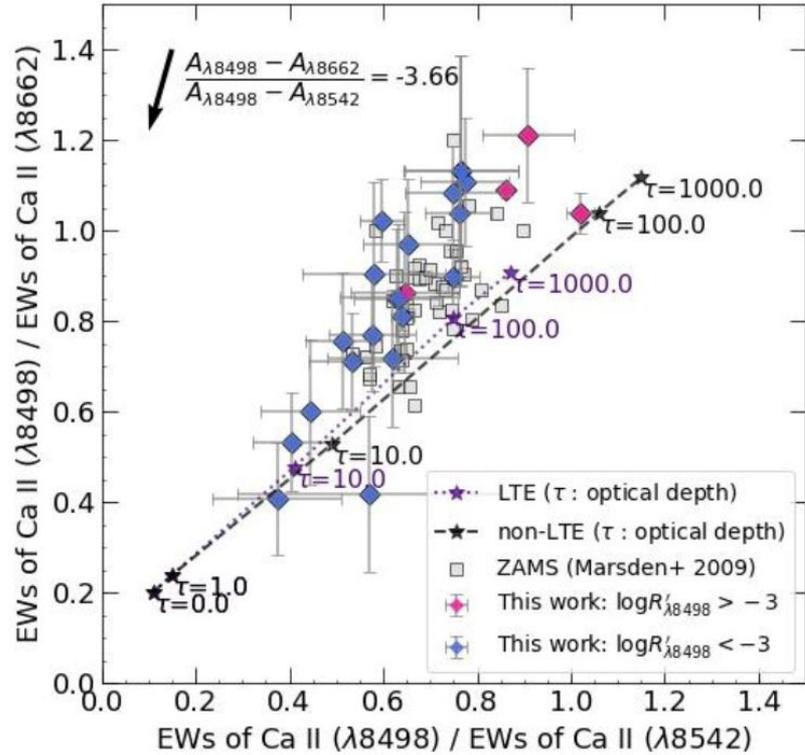
Inoue:

- I investigated the dependence of the Fe K α line of pre-main-sequence stars on the distance from the disk center.
- The line should be emitted from the inner edge of the disk (less than 5 au).

Yamashita:

- I constructed simple models of chromosphere.
- The line strength is not consistent with the observational results of pre-main-sequence stars, which may result from the shock of mass accretion from the disk.

Special thanks to many teachers



The line strength ratio (8498 Å : 8542 Å : 8662 Å) was about 1 : 9 : 5.

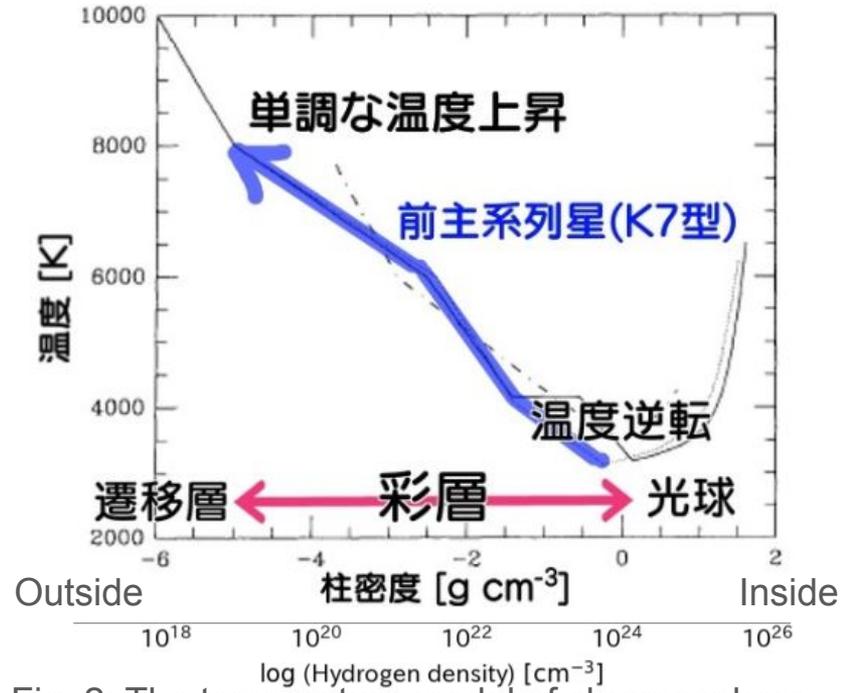
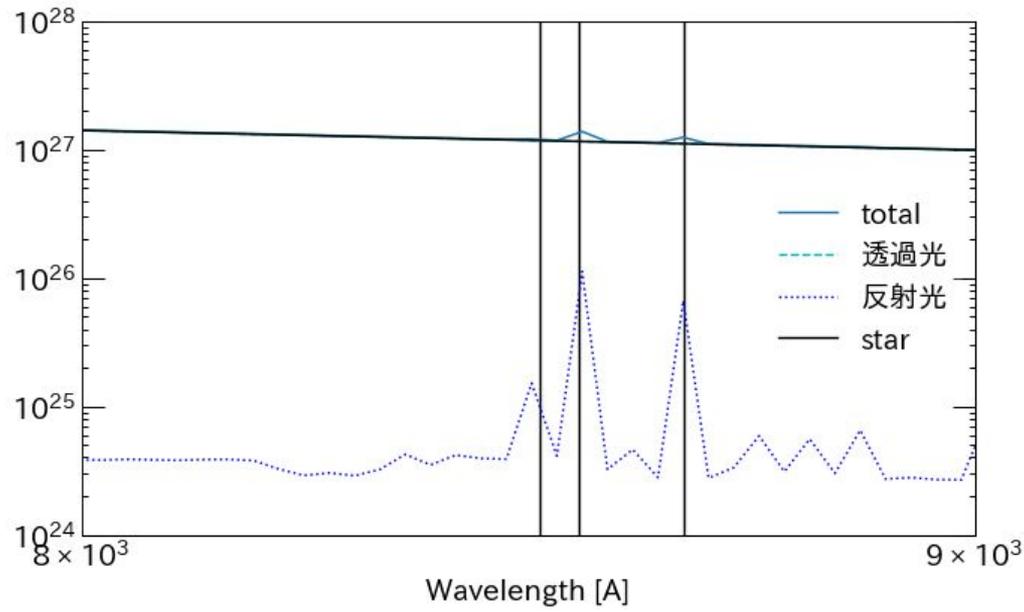


Fig. 2: The temperature model of chromosphere of the T Tauri star (Batalha & Basri 1993)

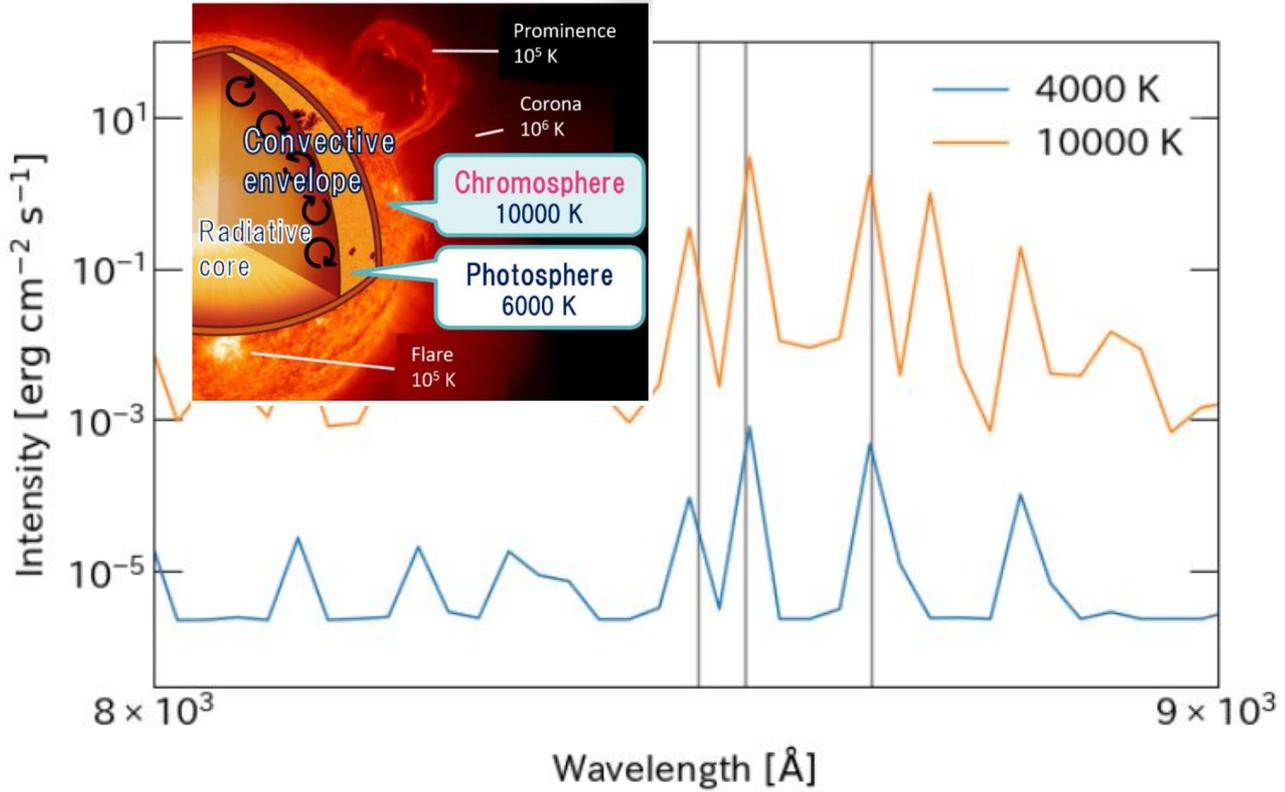
Yamashita's work: Drawing chromospheric emission lines

Chromosphere is active atmosphere between photosphere and corona.

I calculated the chromospheric Ca II emission lines at 8498, 8542, 8662 Å.

(e.g. coronal 4000 K)

Now I am trying to get line ratio with the grid of temperature and Hydrogen density.



Thank you again today, many teachers !

Yamashita's work1: simple model

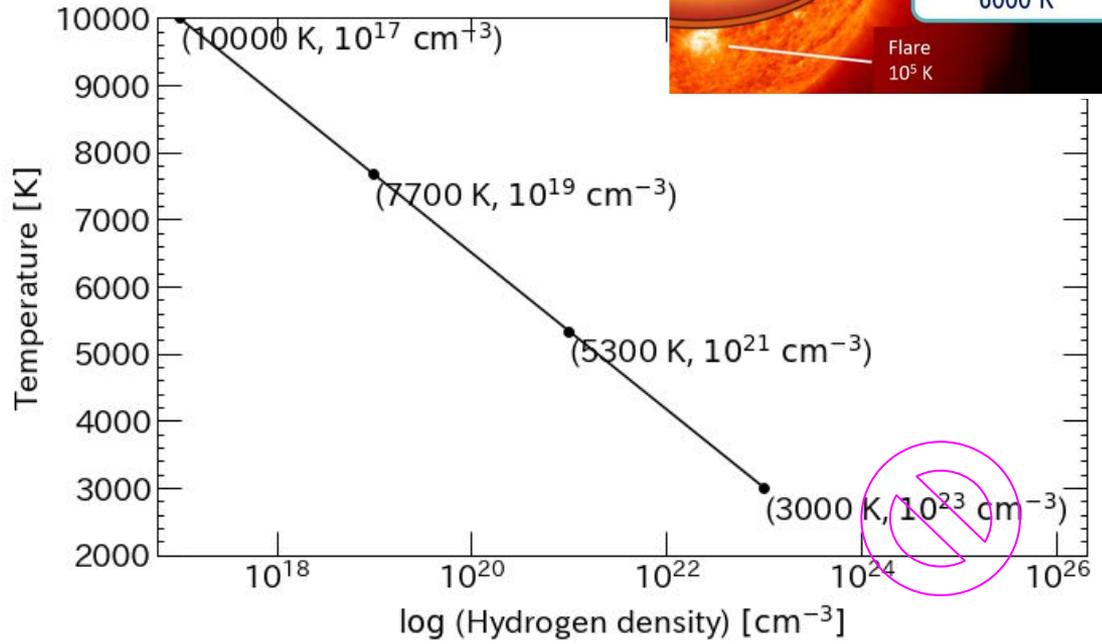
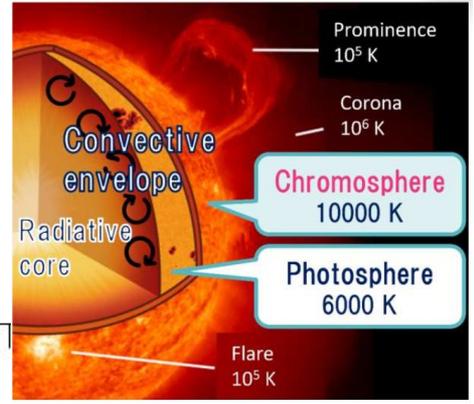
My goal is to get a chromospheric structure, and study about the relationship between it and the stellar evolution.

I constructed a very simple model of chromosphere.

x axis: Hydrogen density

y axis: Temperature

I tried to calculate the four models. One of them did not work.



Very simple chromospheric model

Yamashita's work2: Line ratio

chromospheric Ca II
emission lines at 8498,
8542, 8662 Å

The line strength ratio
(8498:8542:8662) is about
1 : 9 : 5.

It is not consistent with the
observational results.
Tomorrow I will tell you the
discussion about it.

