# Dusty H I Shells

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with Richard Wünsch, James Dale and Kevin Douglas

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Presented by Vojtěch Sidorin

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# Talk Outline

1. Observation – Shells in the Milky Way
2. Theory – Origin and Impact of Shells
3. Simulations – Numerical Approach
4. Our Research

# Observation – Shells in the Milky Way

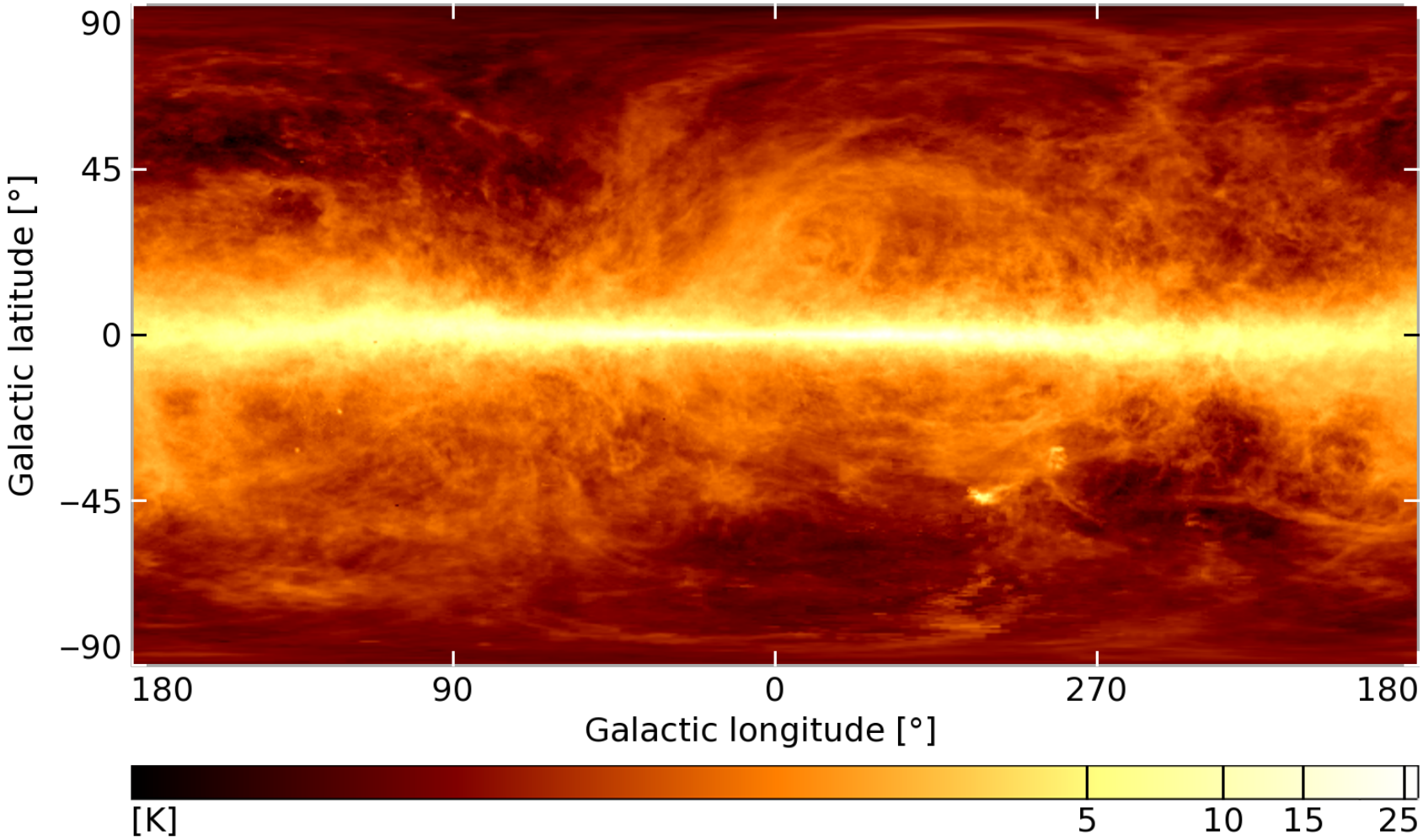


Figure: Neutral hydrogen in our Galaxy. 21 cm line. Brightness temperature averaged over the radial velocities $\pm$ 250 km/s. (LAB Survey, Kalberla et al., 2005)

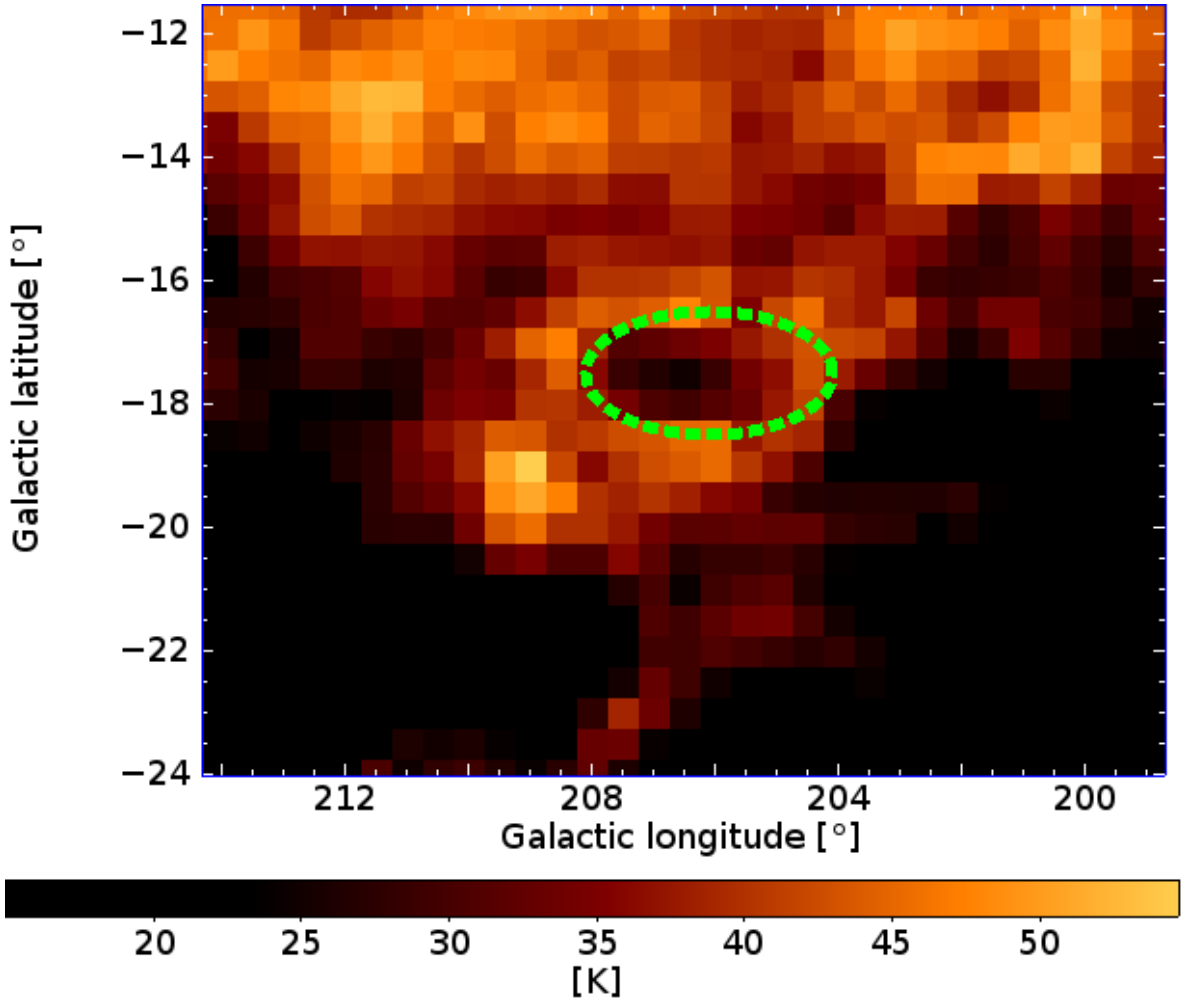


Figure: An example of an H I shell.

## Observed properties of shells

- Size $\propto$ 0.1 pc up to more than 1 kpc
- Embedded energy up to $10^{54}$ erg
- Age $\propto$ 1 Myr up to several 10 Myr
- Expansion velocity up to about 40 km/s

## Spatial distribution of shells

- In every direction
- Concentrate towards the galactic disc

# Theory – Origin and Fate of Shells

## Origin of shells

- OB associations: winds and supernovae
- High-velocity clouds
- Gamma-ray bursts
- Turbulence

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## Impact of shells on the environment

- Sponge-like structure of the Galaxy
- Hot gas into the Galactic halo
- Triggered star formation
  - Collect-and-collapse
  - Hitting preexisting molecular cloud
  - Collisions between shells

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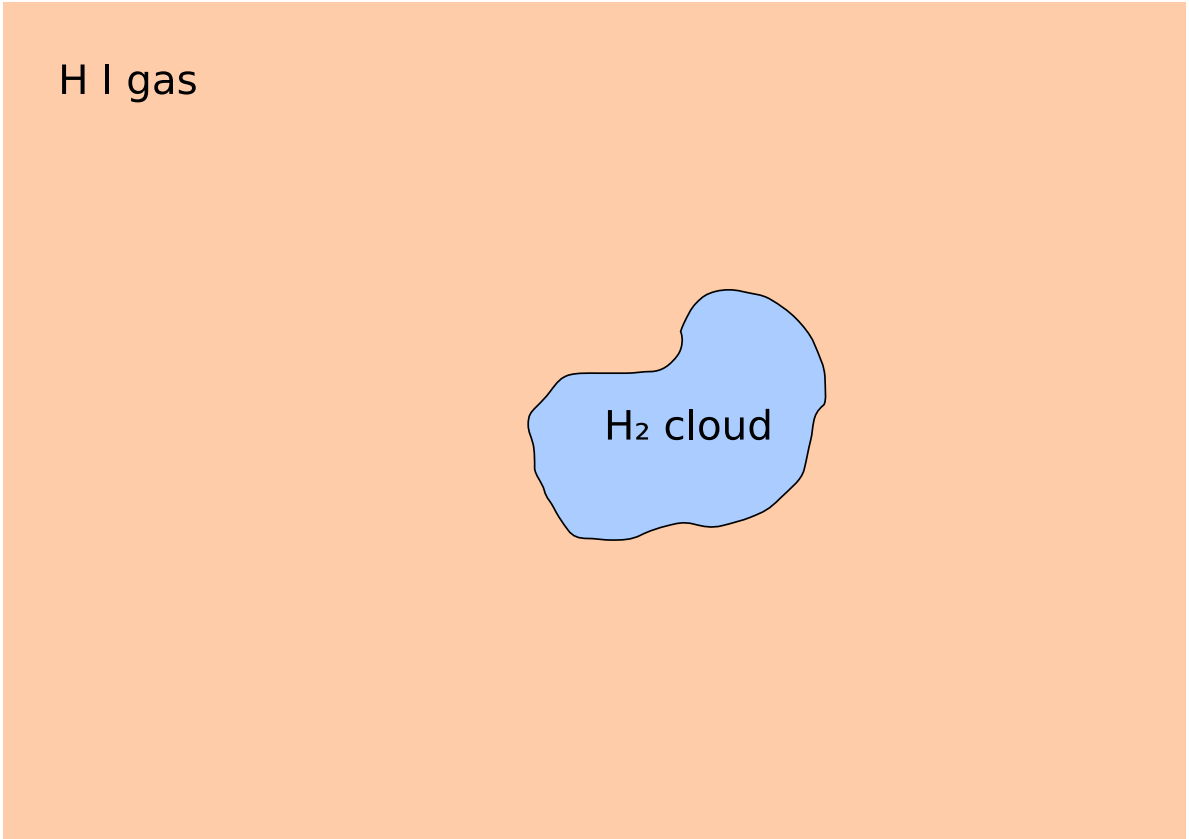
# Life Cycle of Shells



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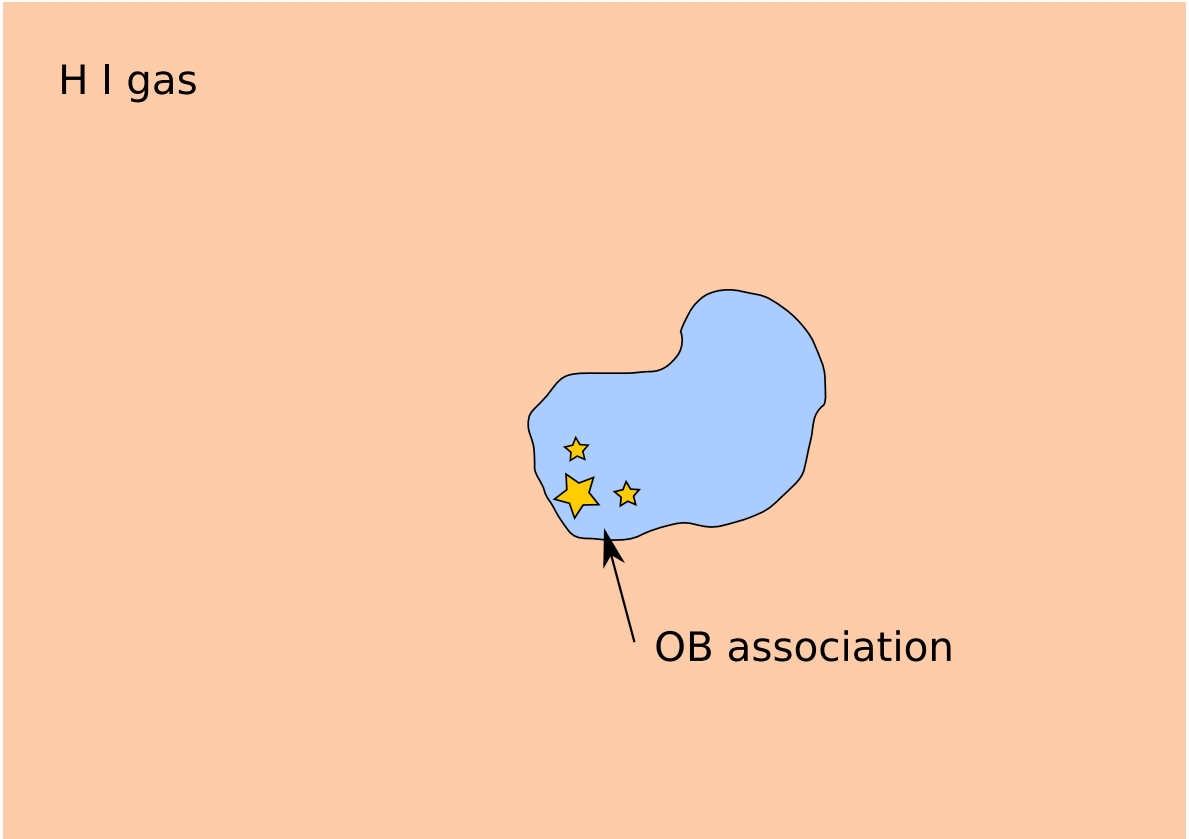

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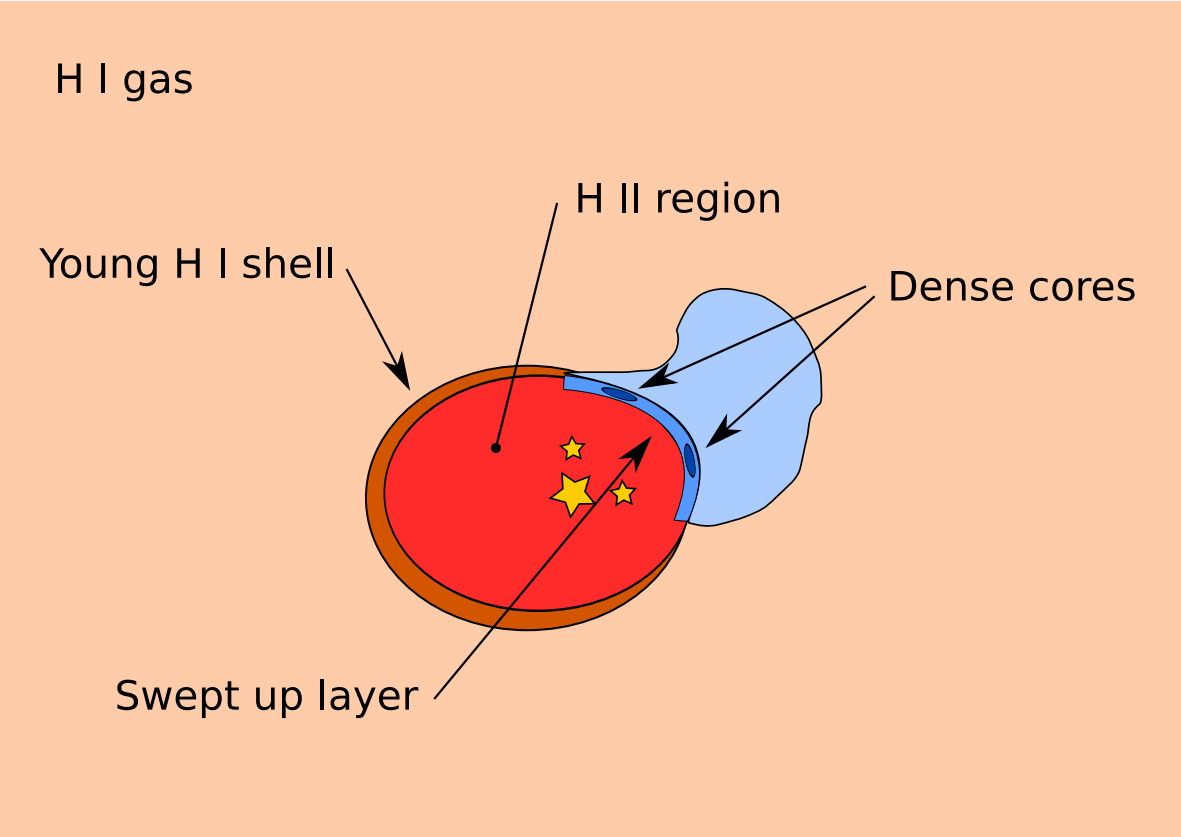

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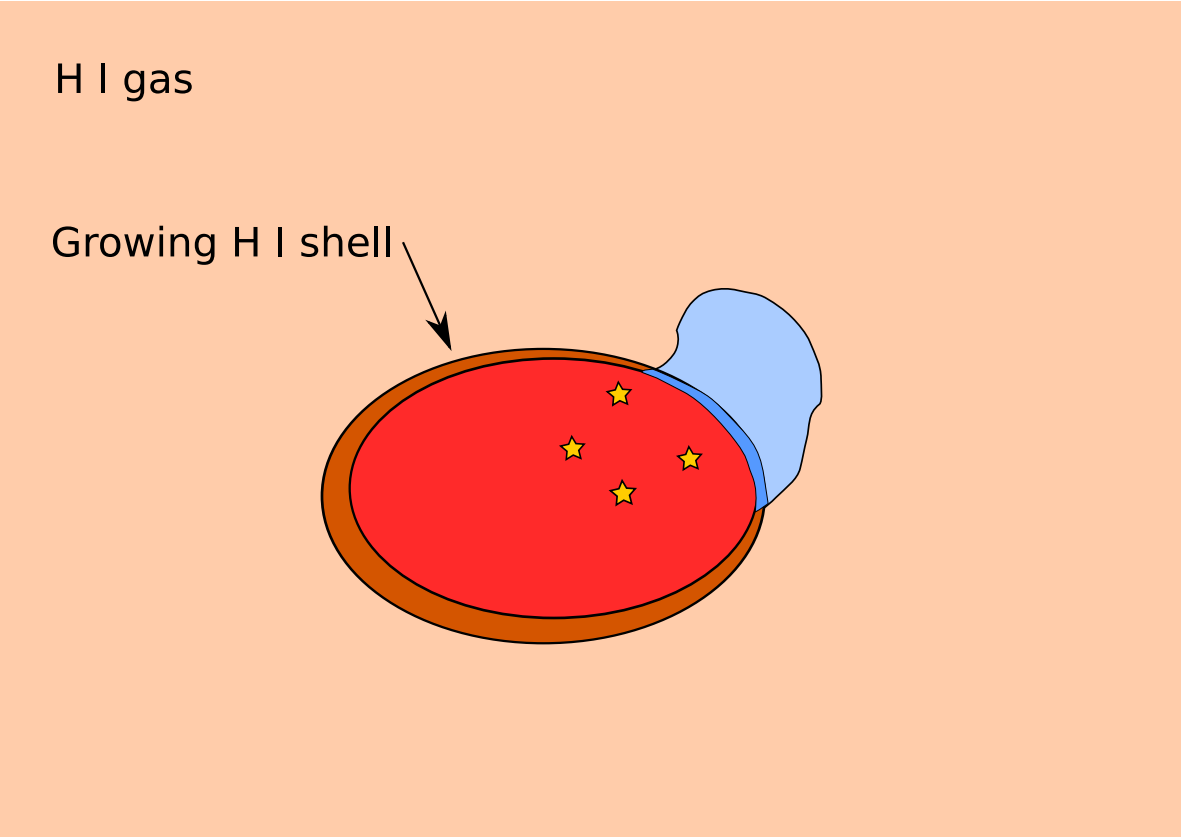

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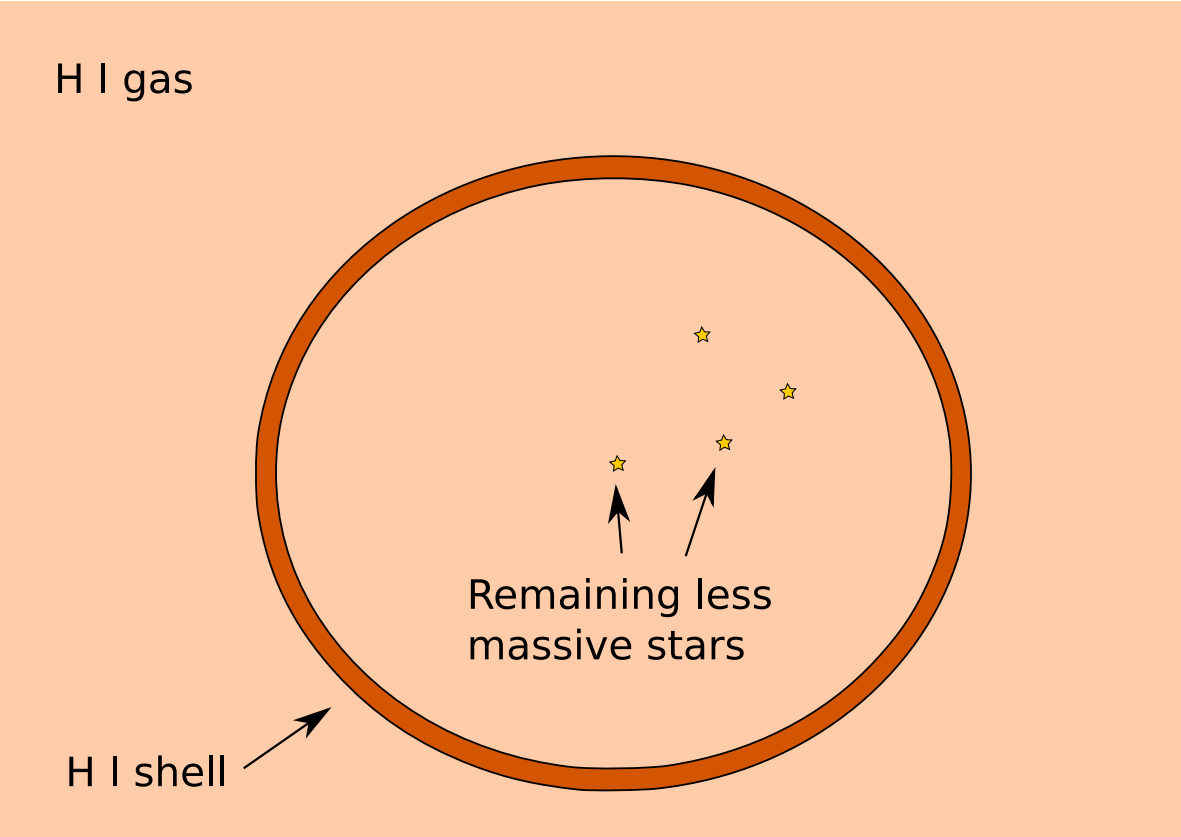

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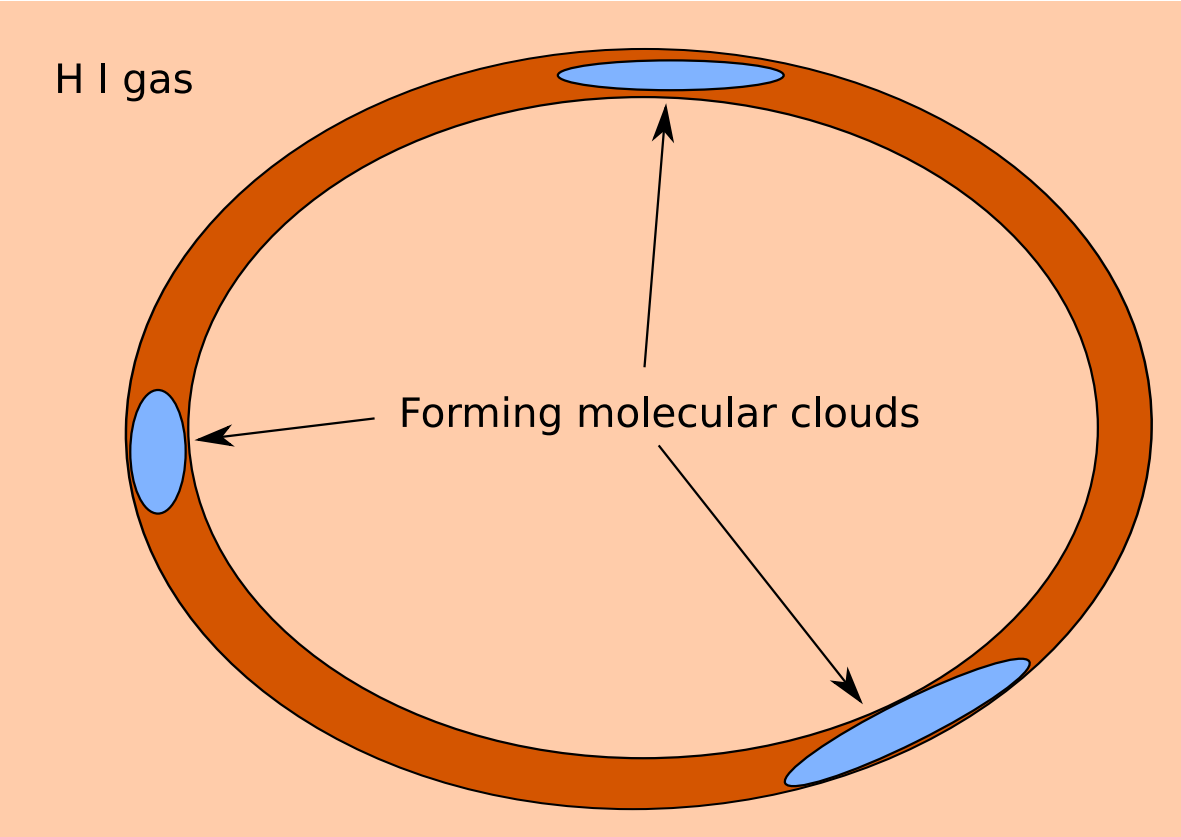

# Simulations – Numerical Approach

# Approaches to Numerical Hydrodynamics

## Adaptive mesh refinement (AMR) (ask Richard Wünsch)

- Eulerian method
  $\longrightarrow$ velocity field
- Adaptive grid
  $\longrightarrow$ refinement, coarsening

## Smoothed particle hydrodynamics (SPH) (ask Jim Dale)

- Lagrangian method
  $\longrightarrow$ trajectories
- Self-adaptive
  $\longrightarrow$ density $\sim$ number of particles

- Dale et al. (2009): AMR and SPH in good agreement

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# Brief Summary of Simulations

## Origin of shells

- No theory ruled out
- Focus on feedback from OB stars

## Impact of shells on the Galactic environment

- No theory ruled out
- Focus on global Galactic structure and collect-and-collapse scenario

## Practical results of simulations (practical for an observer)

- Shells' properties follows from the mechanism of creation
- Fragmentation in the collect-and-collapse model
- Evolution in non-homogenious medium

# Our Research

# Shell in Orion

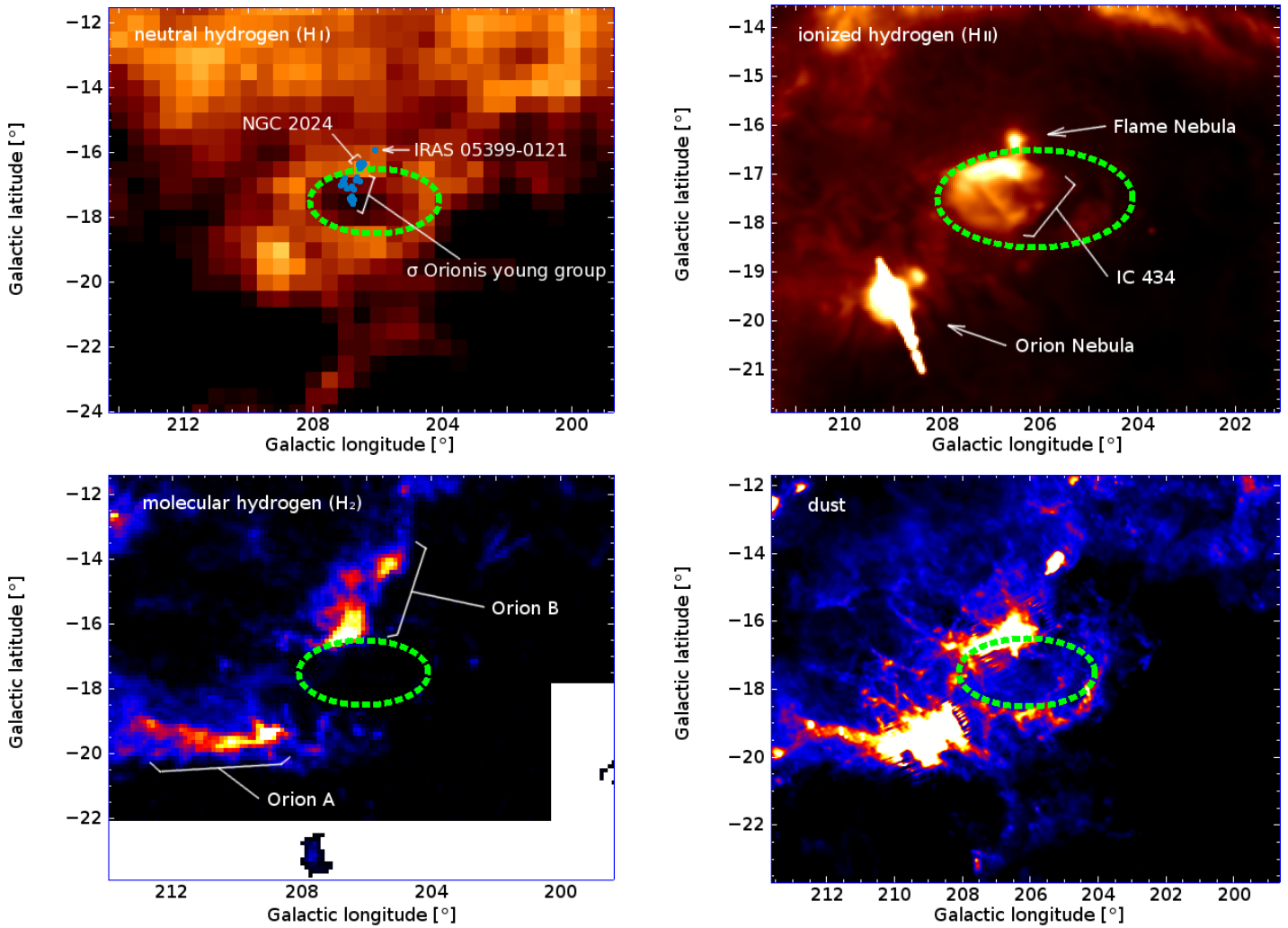


Figure: Shell in Orion (GS206−17+013). Adopted from Sidorin (2008).

# Dusty H I Shell

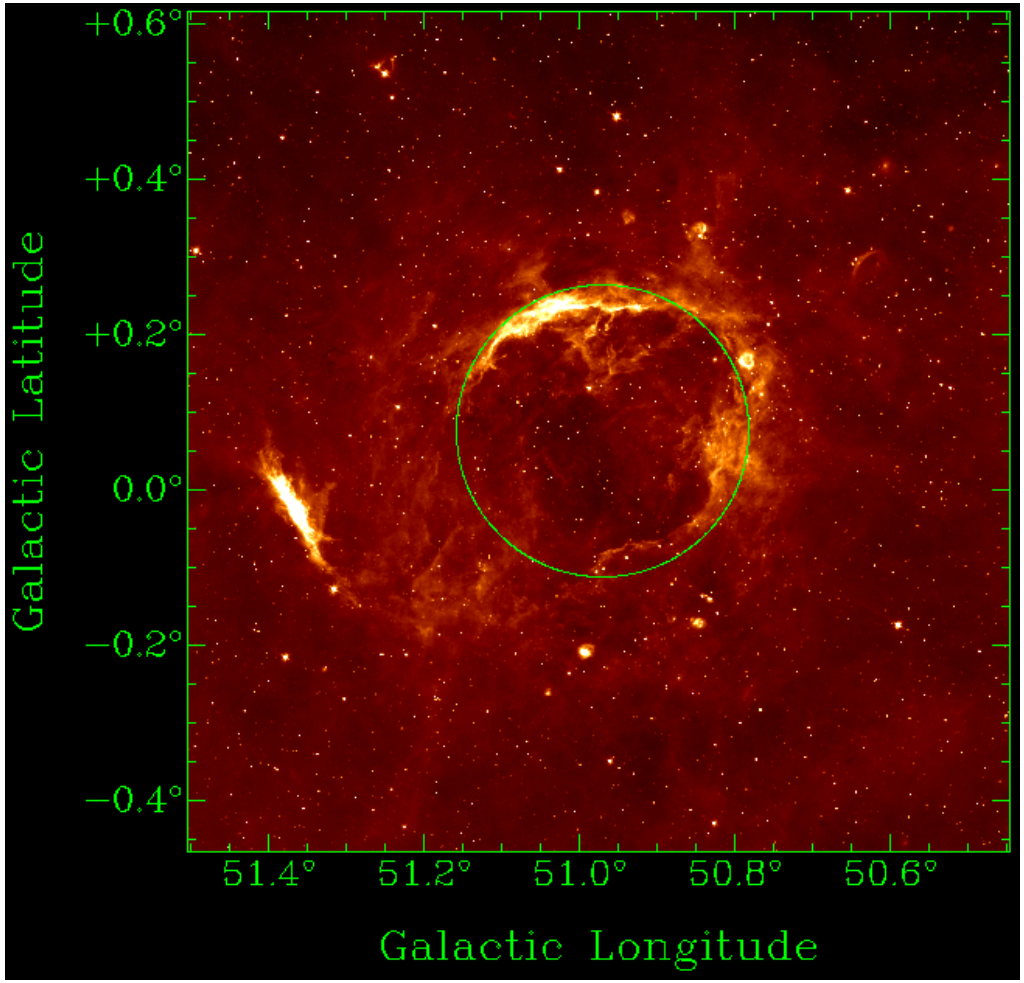


Figure: Dust bubble (N107) discovered by Churchwell et al. (2006).

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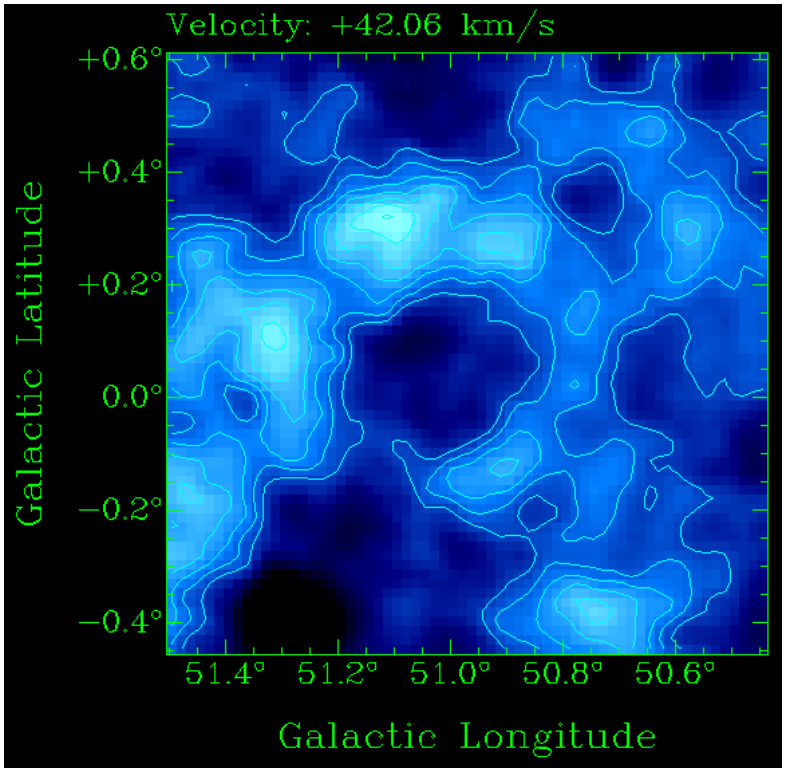


Figure: Counterpart H I shell, found using the I-GALFA survey. (Sidorin & Douglas & Palouš, ongoing research)

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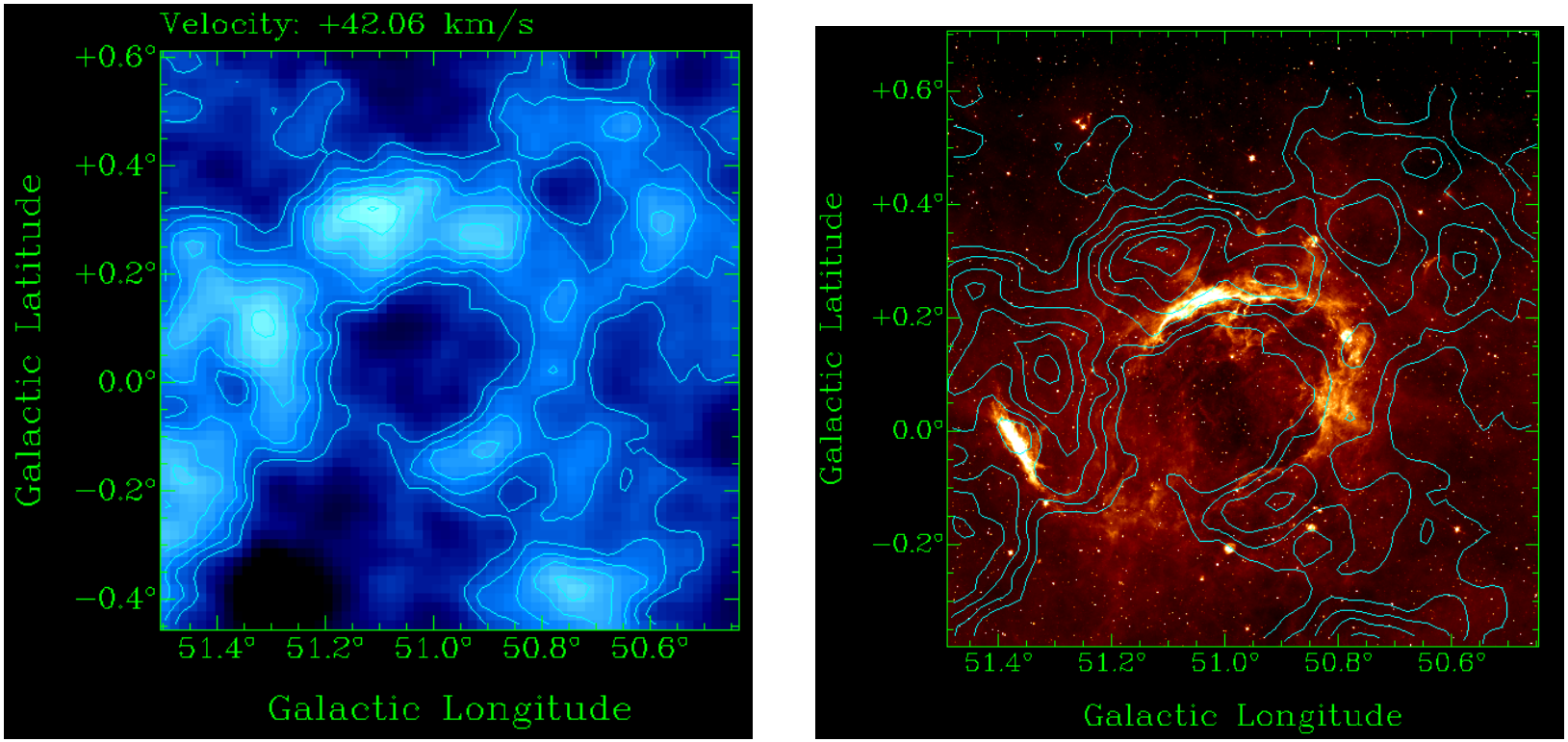


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# Summary

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## Observation

- Shell-like structures are prevalent features in gas-rich galaxies.

## Theory

- Different origin, mostly OB associations
- Collect-and-collapse as a propagator of star formation

## Simulations

- Two approaches: AMR and SPH
- Focused on triggered star formation

## Our research

- Ongoing: multiwavelength study of dust/gas shells (Spitzer & Arecibo)

# Contacts


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# Supplements

# References I


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- Dale, J. E., Wünsch, R., Whitworth, A., & Palouš, J. 2009, MNRAS, in press
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- Sidorin, V., *IR, optical and X-ray counterparts of H I shells in the Milky Way*, Master's thesis, Charles University in Prague, 2008

# Technical Notes

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