Dynamical study of the MW Nuclear Stellar Cluster and its Secular Evolution

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in coll. with

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Nuclear Stellar Clusters

$M \sim 10^{6\text{-}7}\ M_\odot$ $L \sim 10^{6\text{-}7}\ L_\odot$ $R_{hl} \sim$ 2-5 pc $\rho \sim 10^{6\text{-}7}\ M_\odot\ pc^{-3}$

The densest stellar systems in the Universe

- Old (> 1 Gyr) and young (< 100 Myr) stellar population
- Stars do not share a common birth
- Two competing models of formation:

Dissipative scenario

"*in-situ model*"

(Bekki, 2007)

Dissipationless scenario

"dry merging model"

(Capuzzo Dolcetta ,1993)

There are many observational evidence favoring the dry merging model

(Arca Sedda & Capuzzo Dolcetta, 2014/2016)

(Minniti et al., 2016)

(Brandt & Kocsis, 2015)

State of Art

Only few works concerning the NSC secular evolution!

NSC dynamics cannot be followed with high precision, direct summation available N-body codes!

See Taras's talk

Scientific Challenge!!

HiGPUs

A fully parallel, high precision, *N*-body code running on hybrid computing platforms

R. Capuzzo–Dolcetta[a], M. Spera[a], D. Punzo[a]

[a]*Dep. of Physics, Sapienza, University of Roma, P.le A. Moro 1, Roma, Italy*

(2013)

up to 10 millions stars

Nbody6++gpu

NBODY6++GPU: ready for the gravitational million-body problem

Long Wang,[1,2★] Rainer Spurzem,[3,4,5,1] Sverre Aarseth,[6] Keigo Nitadori,[7]
Peter Berczik,[3,4,5,8] M. B. N. Kouwenhoven[1,2] and Thorsten Naab[9]

(2015)

Our Project

What:

Dynamical secular evolution of the MW NSC

How:

Direct N-body simulations carried out with NBODY6++gpu /HiGPUs

crucial point of our work!!!

Goals:

Investigation of the NSC evolution towards Relaxation

Core collapse (CC) may occur in the NSC?

Can the binary content of the NSC prevent the CC?

The MW NSC

from a physical point of view…

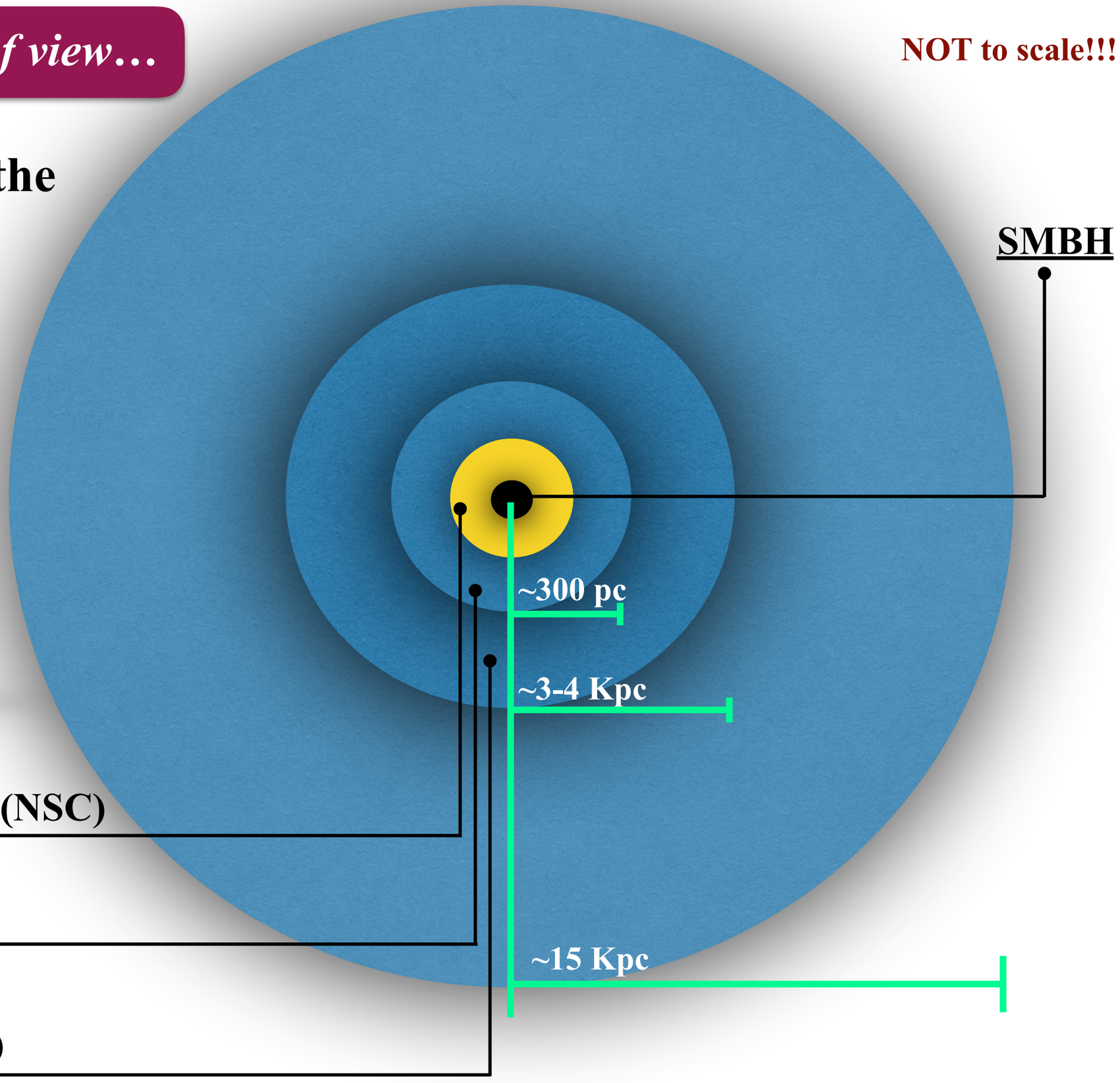
NOT to scale!!!

“Rough” scheme of the Galaxy

$L_{NSC} = 4.1 \cdot 10^{7}\ L_{\odot}$

$R_{NSC} = 4.2$ pc

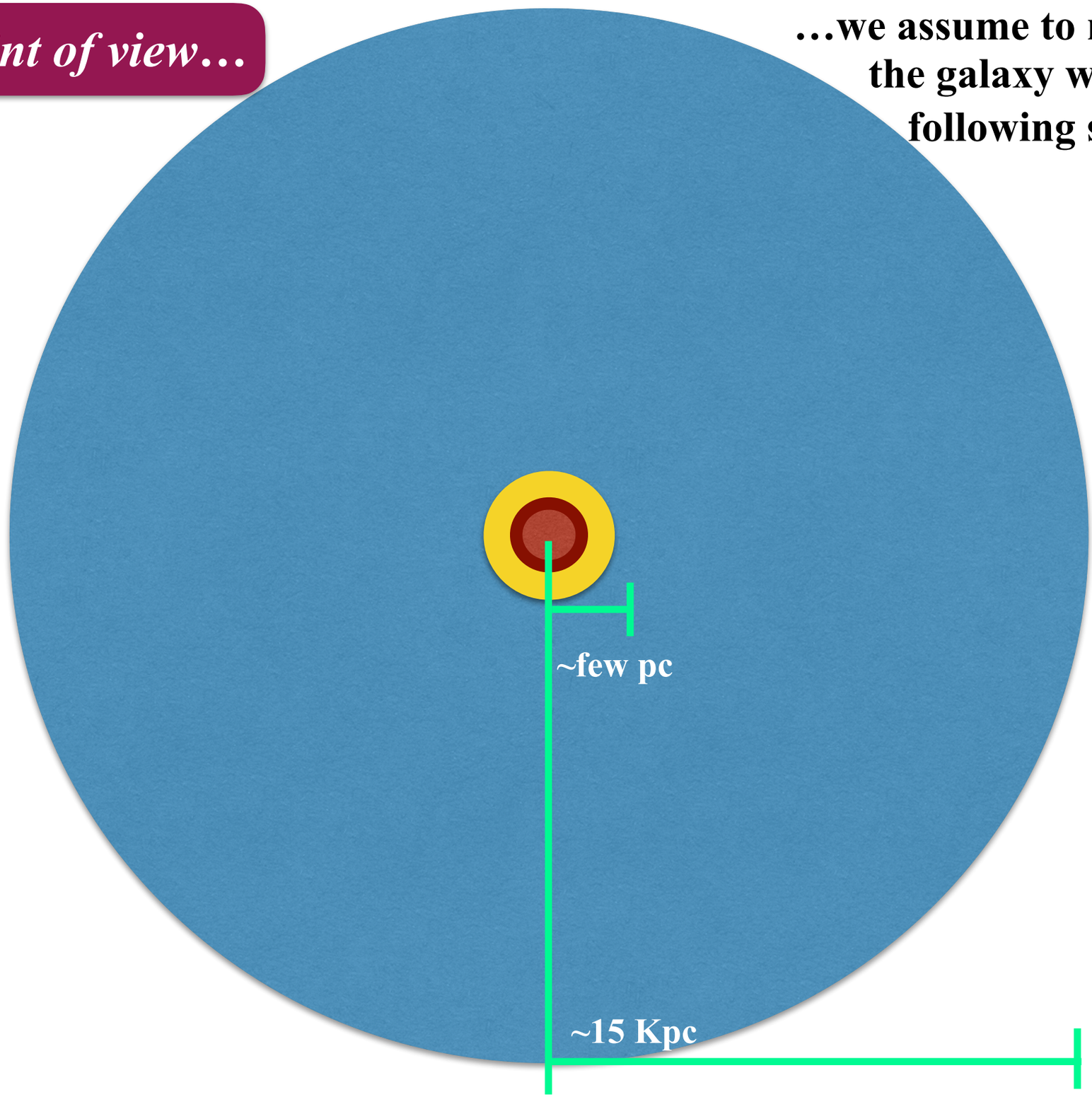
$M_{NSC} = 2.5 \cdot 10^{7}\ M_{\odot}$



The MW NSC

from a computational point of view…

…we assume to model the galaxy with the following scheme…

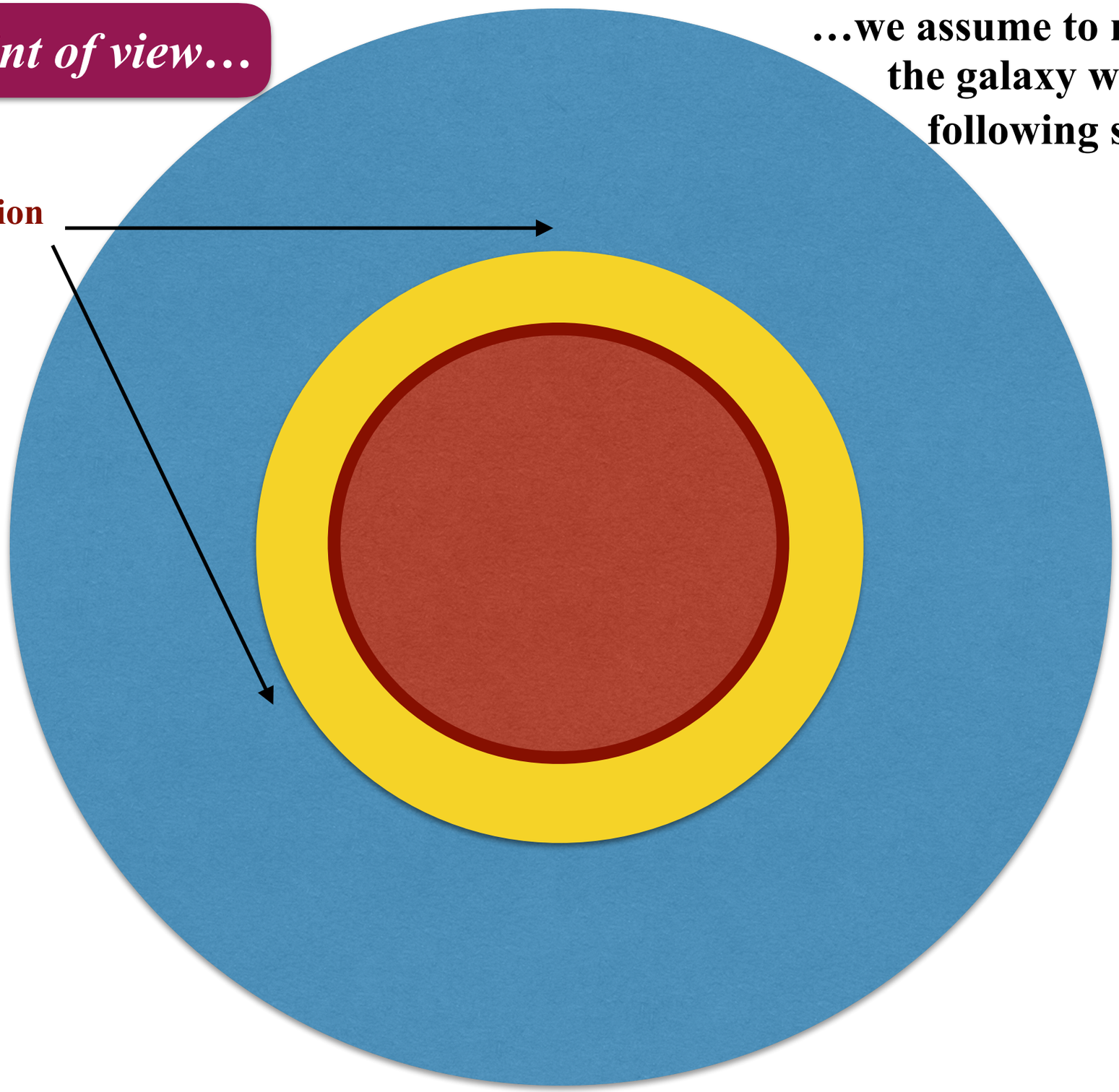


The MW NSC

from a computational point of view…

…we assume to model the galaxy with the following scheme…

Zoom of the central region



The MW NSC

from a computational point of view…

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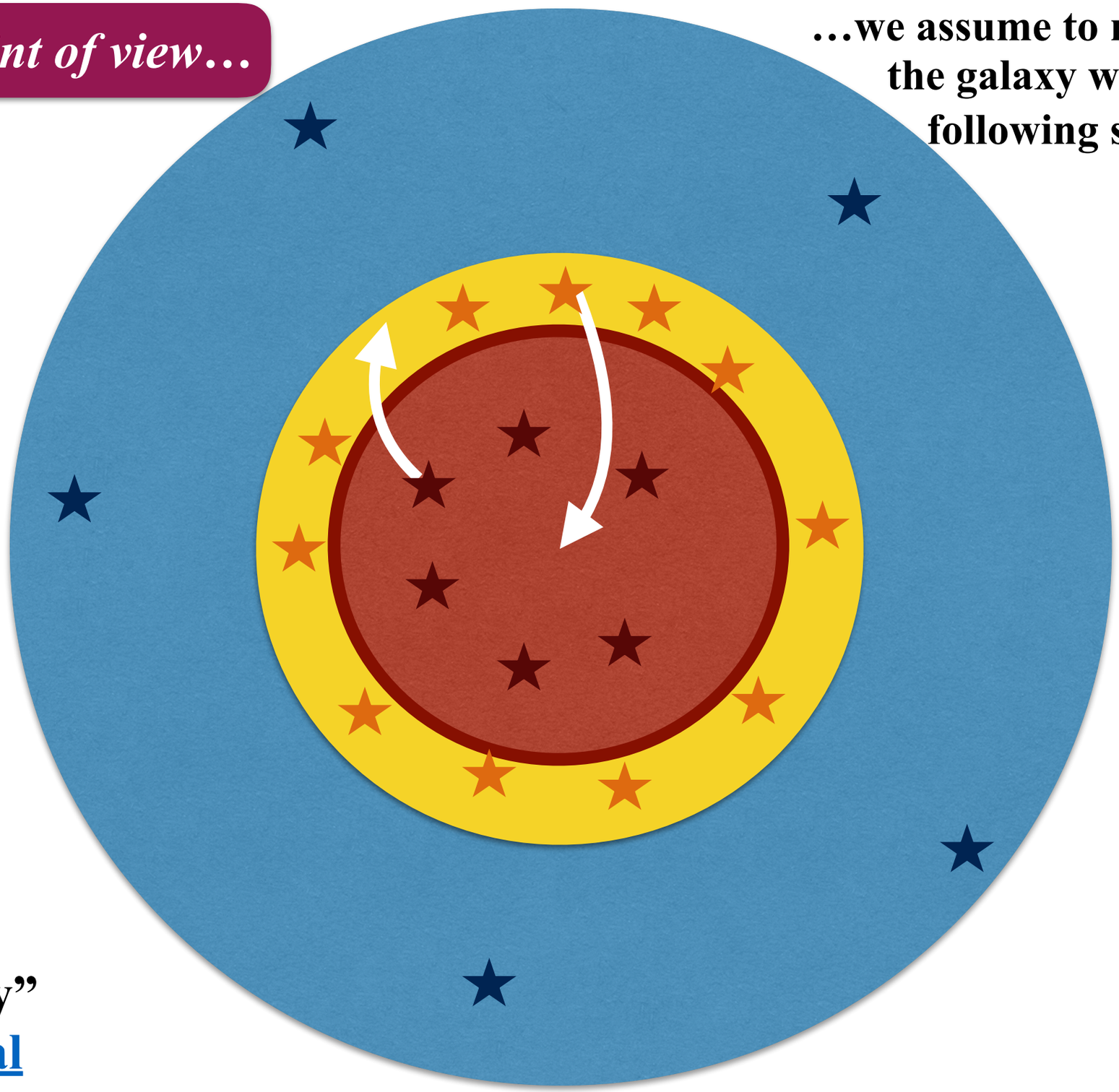

Sampling Area
Direct N-body summation

Boundary Area

“Rest of the Galaxy”
External Potential

Our Strategy

NSC already formed (dry-merging model)

Direct N-body simulations without any scaling

- Direct n-body approach for the stars which belong to the sampling area
- Special dynamical treatment (***) of stars that cross the boundary area (incoming-outcoming)
- Taking into account external components of the galaxy as an external potential

(***) suitable modifications of routines in

Nbody6++gpu & HiGPUs

Thank you!