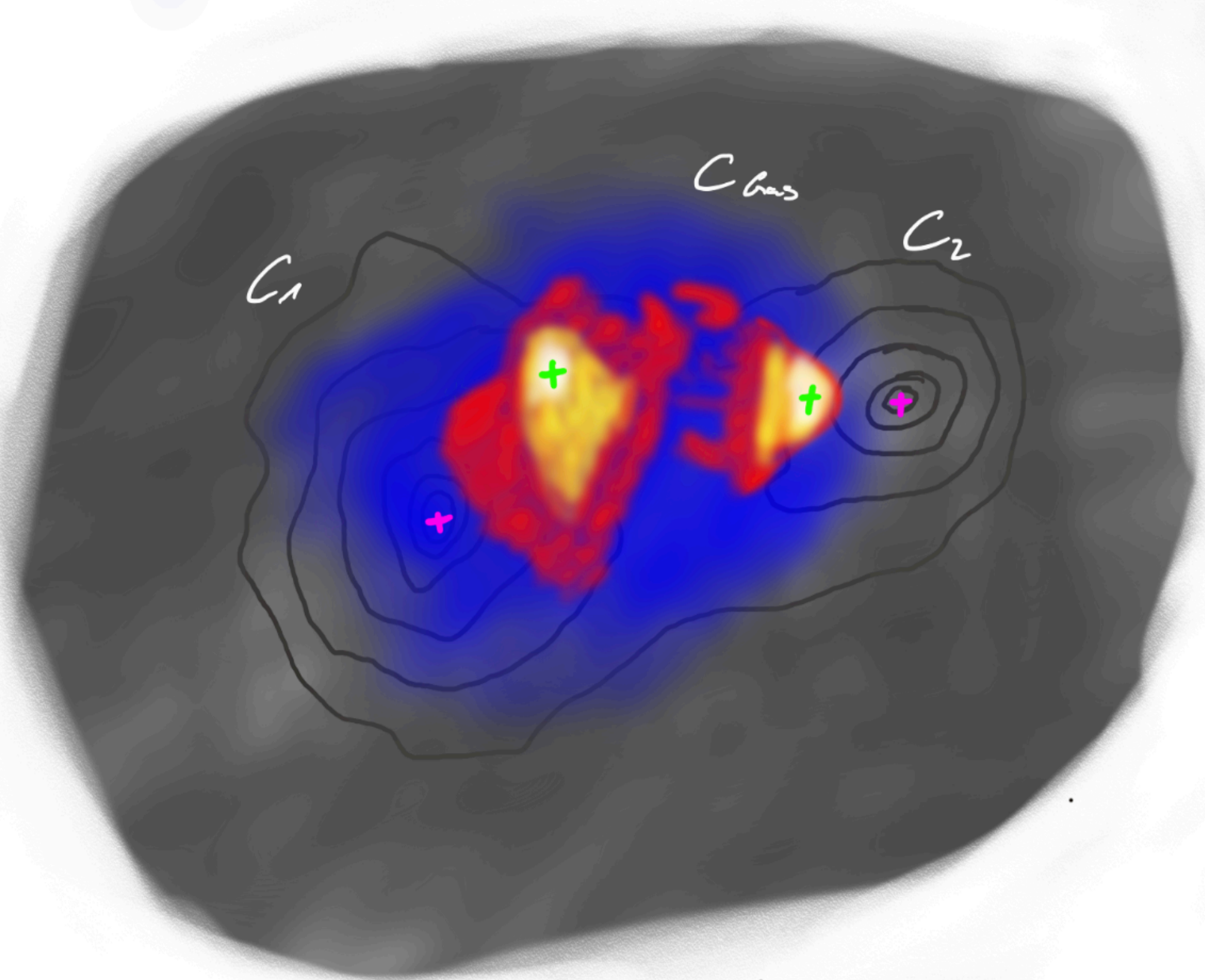


Explanation of the dynamics of the Bullet Cluster by the consideration of a modified Holographic Principle

Sketch of the Bullet Cluster



+ Center of mass for visible mass ( $C_{gas}$ )  
 + Center of mass from weak lensing reconstruction  $\rightarrow$  corresponds to Galaxy to DM distribution  
 $C_1, C_2, C_{gas}$   $\hat{=}$  Massical distribution within Bullet Cluster

Holographic consideration of the Bullet Cluster:

$$F = T \nabla_x S \quad S = S_{C_1} + S_{C_2} + S_{C_{gas}}$$

$$dE = T ds \quad S_{C_{gas}} \hat{=} \text{Thermodynamic States of Plasma}$$

$C_1 = \sum_i C_{1,i} \rightarrow C_{1,i} \hat{=} \text{Single Galaxies in } C_1;$   
 Thermodynamic System with ordinary matter

$$C_2 = \sum_i C_{2,i}$$

$$\text{whereas } S(C_{1,i}) = S_{C_{1,i,b}} + S_{C_{1,i,L}}$$

Entropy due to baryonic matter

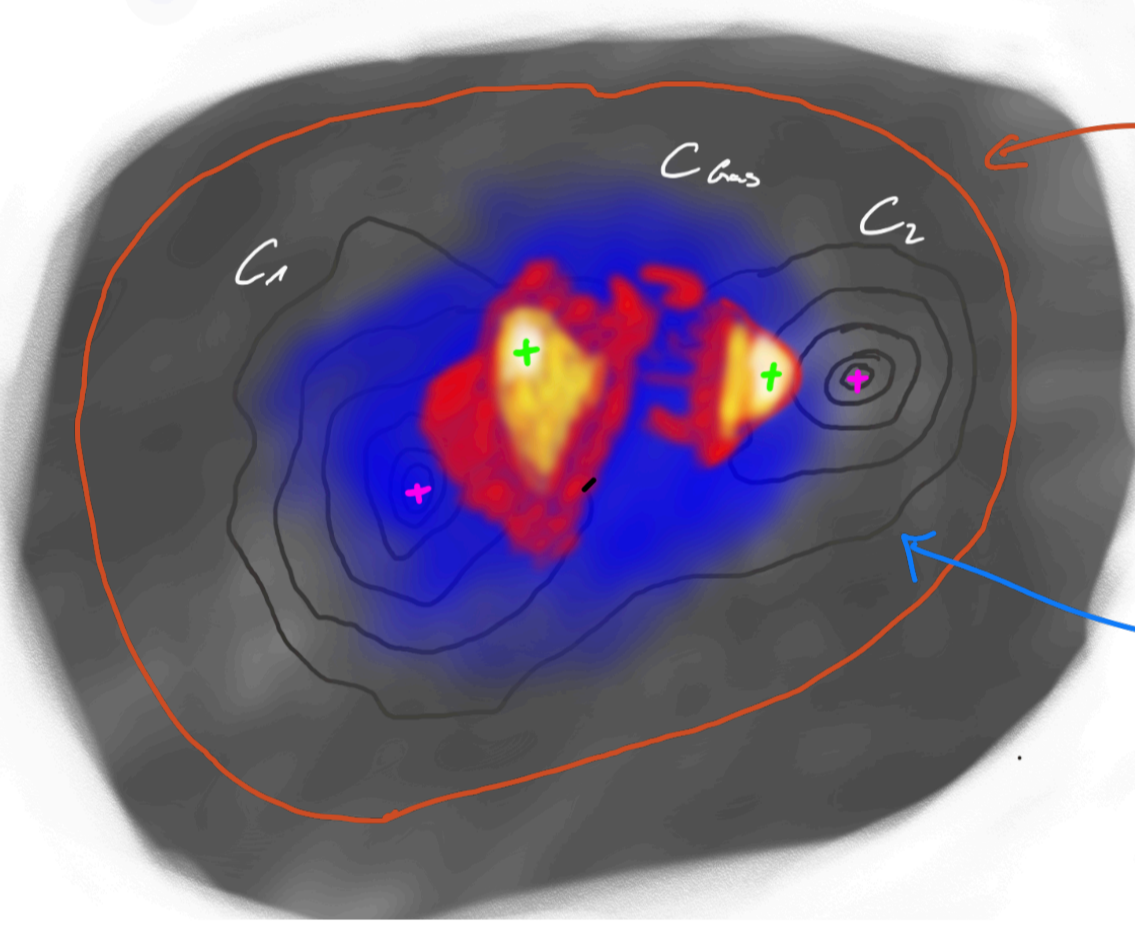
Entropy due to Life

$$\begin{aligned} \rightarrow S_{C_1} &= \sum_i S(C_{1,i}) = \sum_i (S_{C_{1,i,b}} + S_{C_{1,i,L}}) \\ &= \sum_i S_{C_{1,i,b}} + \sum_i S_{C_{1,i,L}} \end{aligned}$$

$$\rightarrow S_{C_2} = \sum_i S_{C_{2,i,b}} + \sum_i S_{C_{2,i,L}}$$

$\rightarrow S_{C_{gas}} \hat{=} \text{Entropy of hot, thermodynamic matter system (colliding Gas/matter)}$

Consideration of holographic field II with Area A ( $\partial B_{ST}$ ) consisting of states from volume V with boundary  $\partial B_{ST}$  of the Space-Time-Region  $\mathcal{S}_{II}$



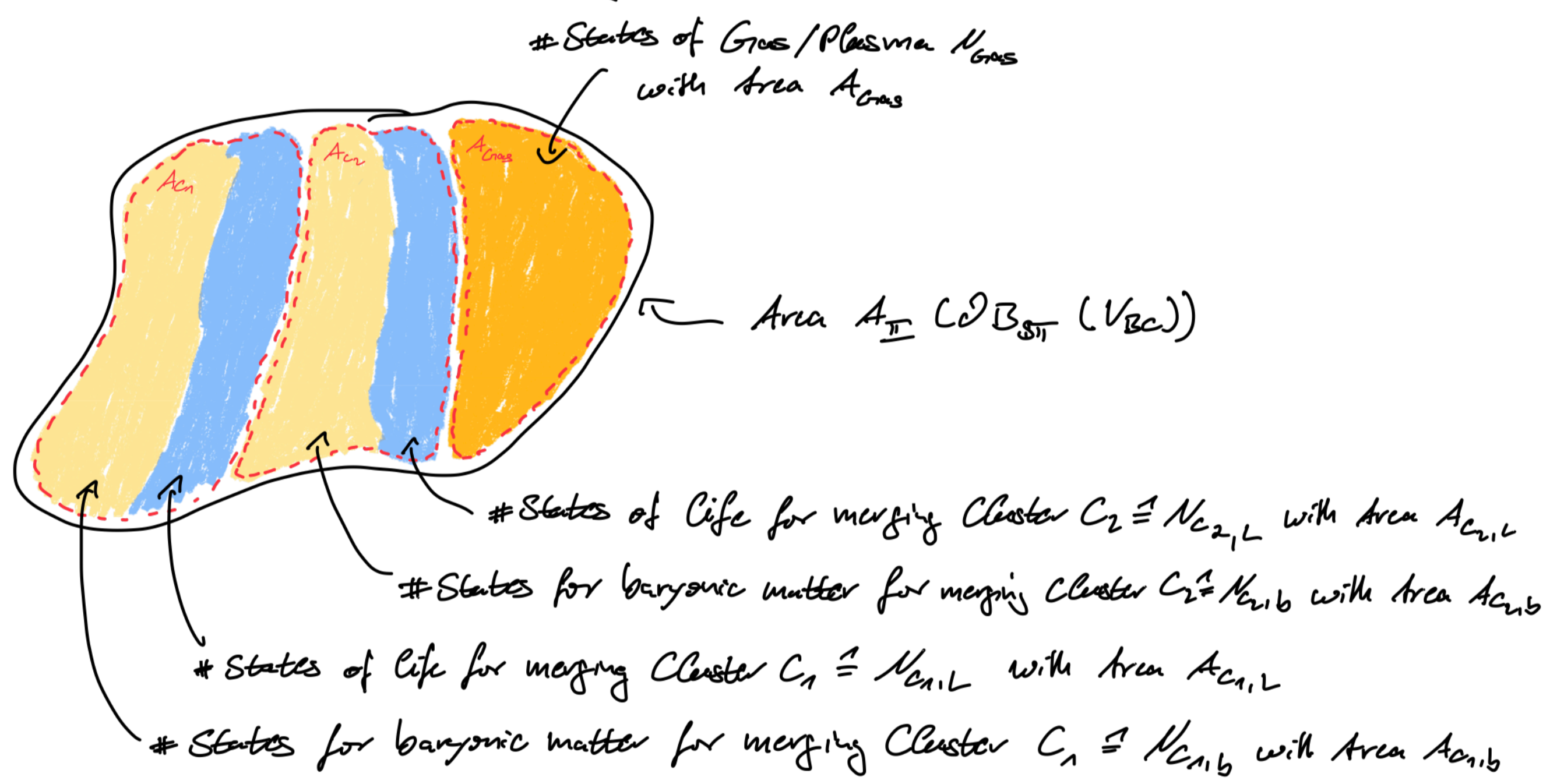
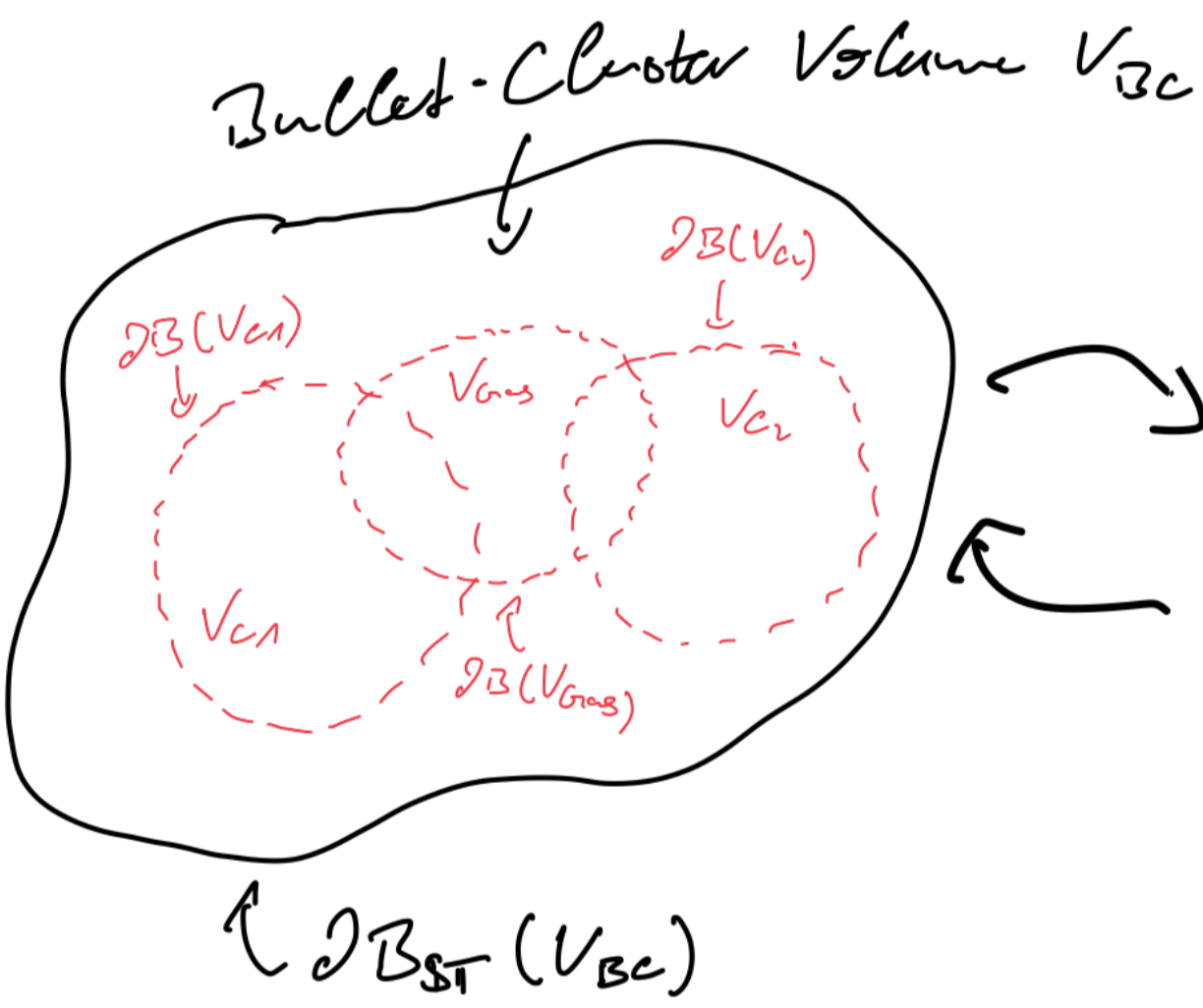
Boundary  $\partial B_{ST} (V_{bc}) \hat{=} \text{Area } A_{II} (\partial B_{ST})$

Space-Time Region / Volume  $V_{bc}$  with Bullet-Cluster

Assumption: Galaxies of  $C_1, C_2$  have a PFR for habitable Planets

Space-Time  $\mathcal{S}_{II}$

Holographic Field II



$$A = A_{C_1} + A_{C_2} + A_{C_{gas}} = A_{C_{1,b}} + A_{C_{1,L}} + A_{C_{2,b}} + A_{C_{2,L}} + A_{C_{gas}}$$

$$\text{with } N = N_{C_{1,b}} + N_{C_{1,L}} + N_{C_{2,b}} + N_{C_{2,L}} + N_{C_{gas}}$$

Locally confined in  $\mathcal{S}_{II}$  since life is bounded to baryonic galactic matter!

Derivation of entropic Forces with holographic assumption:

$$\begin{aligned} F &= T \nabla_x S \\ &= T \nabla_x (S_{C_1} + S_{C_2} + S_{C_{gas}}) \\ &= T \nabla_x (S_{C_{1,b}} + S_{C_{1,L}} + S_{C_{2,b}} + S_{C_{2,L}} + S_{C_{gas}}) \end{aligned}$$

Consideration of local Bullet-Cluster  $C_1$ :

$$\begin{aligned} F_{C_1} &= T \nabla_x (S_{C_{1,b}} + S_{C_{1,L}}) \\ &= T \nabla_x S_{C_{1,b}} + T \nabla_x S_{C_{1,L}} \end{aligned}$$

Due to the assumption of a PFR > 0, the argumentation/mathematical description follows the Use-Cases/Manuscript for Galaxies with a PFR.

$$\Rightarrow F_{C_1} = T \sum_i \nabla_x S_{C_{1,i,b}} + T \sum_i \nabla_x S_{C_{1,i,L}}$$

Galaxies in  $C_1$       additional gravity term that shows up as Dark Matter content following the mass distribution of Cluster  $C_1$  (instead of Plasma)

$\Rightarrow$  Signatures of Dark Matter (DM) are collisionless because the Galaxies do not collide and life - and its states being responsible for the additional entropic force - is sustained throughout the Cluster collision.