EARLY WARNING OF CARDIAC PROBLEMS IN A CROWD

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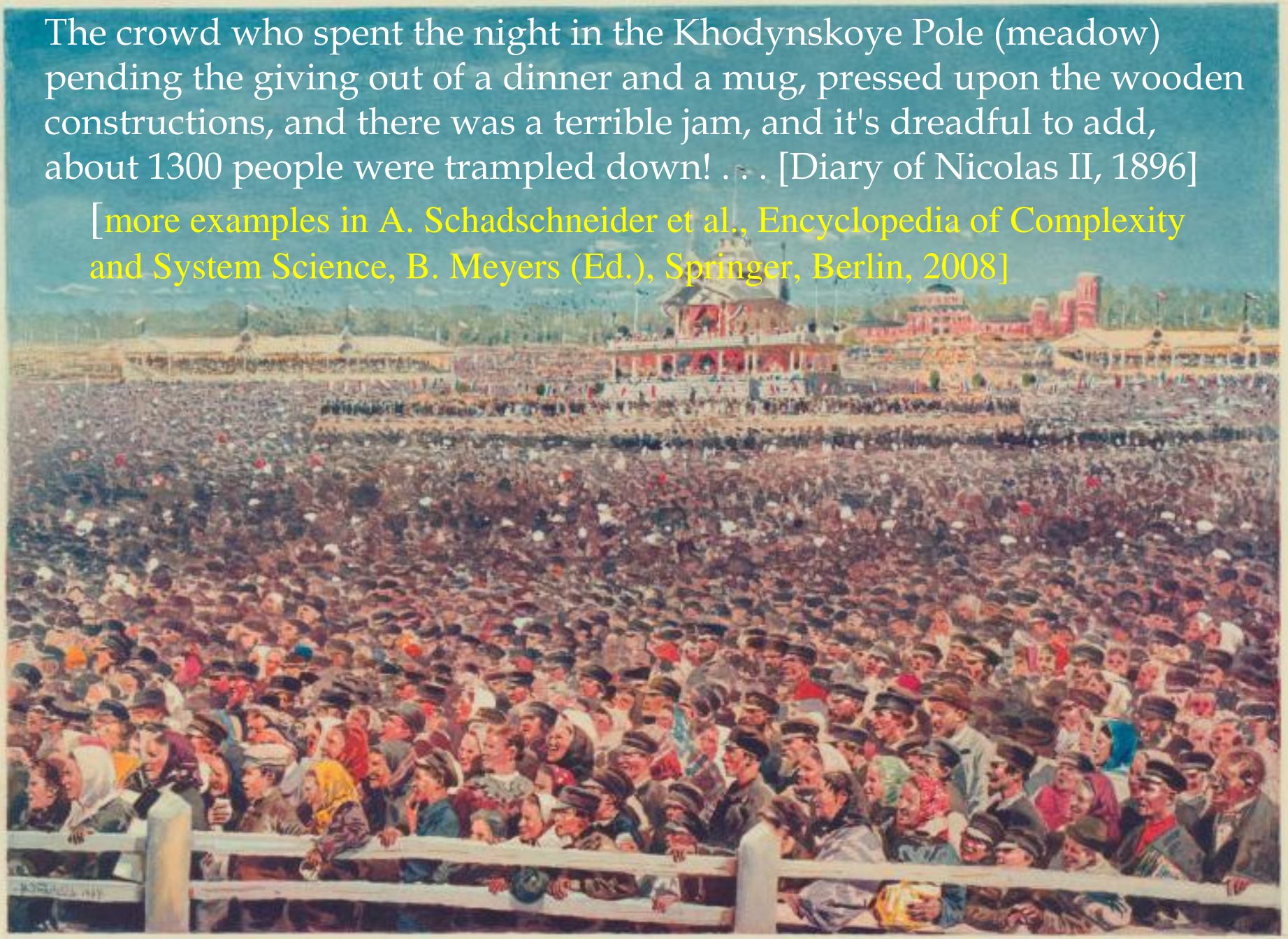
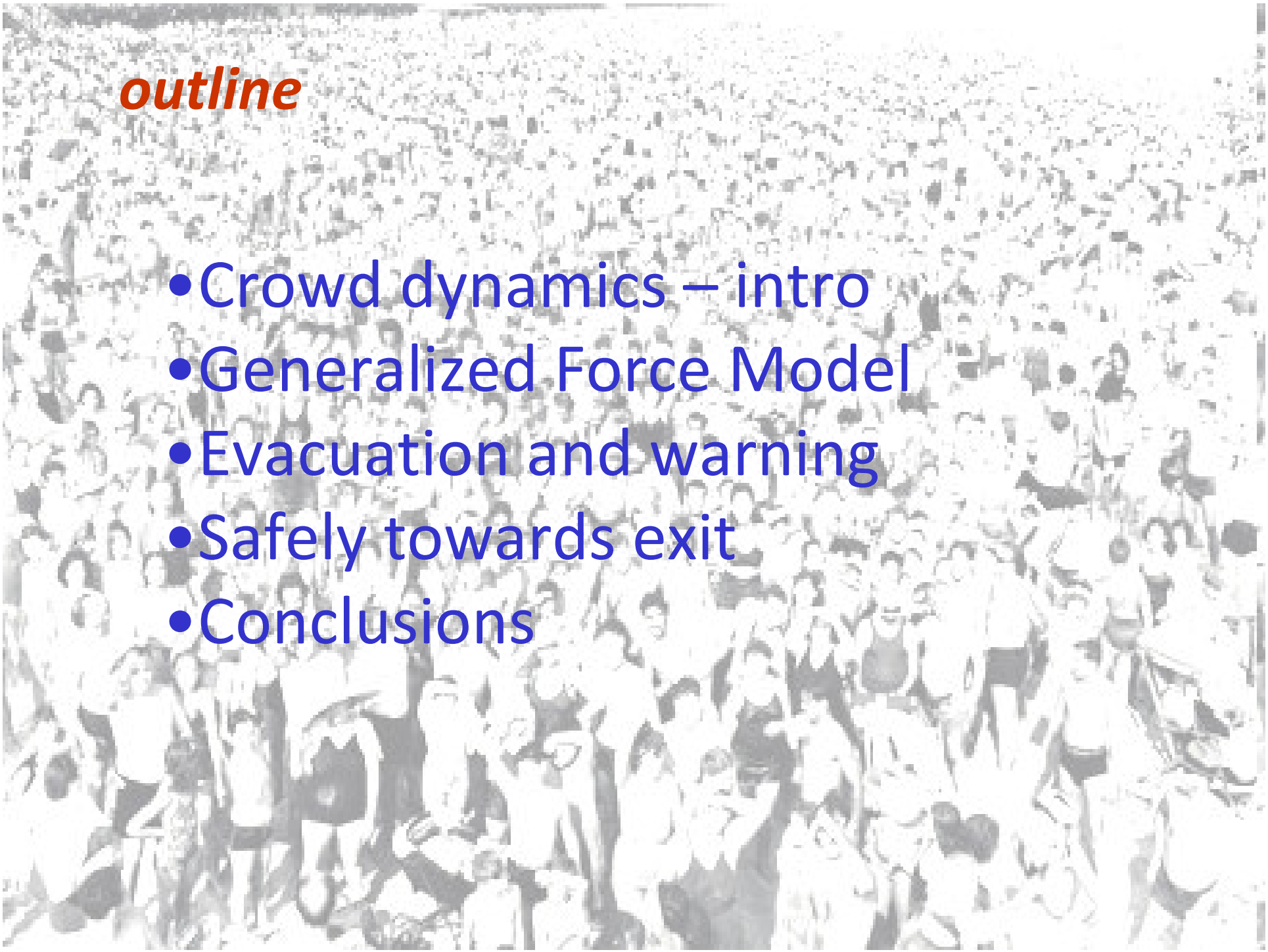
The crowd who spent the night in the Khodynskoye Pole (meadow) pending the giving out of a dinner and a mug, pressed upon the wooden constructions, and there was a terrible jam, and it's dreadful to add, about 1300 people were trampled down! . . . [Diary of Nicolas II, 1896]

[more examples in A. Schadschneider et al., Encyclopedia of Complexity and System Science, B. Meyers (Ed.), Springer, Berlin, 2008]





outline

- Crowd dynamics – intro
- Generalized Force Model
- Evacuation and warning
- Safely towards exit
- Conclusions

Crowd dynamics – intro 1/4 – sociological view

The mere fact that an individual forms part of a crowd, his intellectual standard is immediately and considerably lowered.

[*Gustave Le Bon, La psychologie des foules, 1895*]

Anonymity (lack of criticism by others) should reduce inhibitions of behavior.

[Philip Zimbardo, The Human Choice, 1969]

Norms are effective to the extent that they are seen as a property of the group rather than a position taken by particular individuals within the group.

„redefining the situation, making sense of confusion, is a central activity"

[Ralph Turner and Lewis Killian, Collective Behaviour, 1987]

..crowd members do not simply ask 'what is appropriate for us in this context?' but 'what is appropriate for us *as members of this category* in this context?'. They won't follow anything but only those suggestions that can be seen as appropriate in terms of category identity. They won't follow anyone but only those seen as category members.

[Stephen Reicher, The Psychology of Crowd Dynamics, 2001]

Crowd dynamics – intro 2/4 - observations

- pedestrians choose the *fastest* route to their destination, but not the *shortest* one,

- pedestrians prefer to walk with an individual desired speed,

- pedestrians keep a certain distance from other pedestrians and borders,

- aversion of taking detours or moving opposite to their desired walking direction,

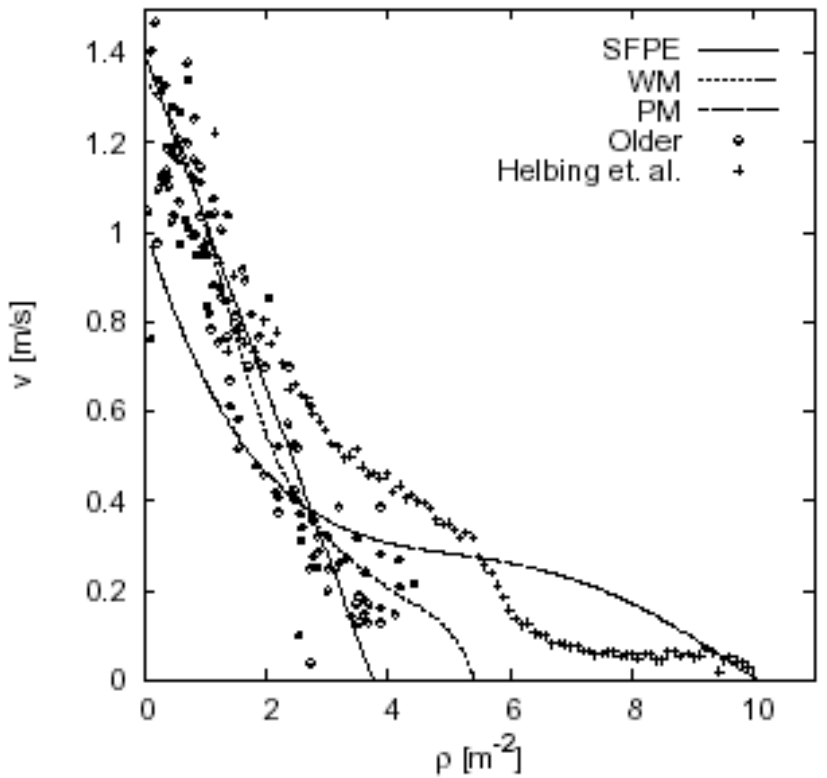
-in situations of escape panic individuals are often nervous, and sometimes they move irrationally. (...) people move or try to move considerably faster than normal. Individuals start pushing, and interactions among people become physical in nature. Moving and, in particular, passing of a bottleneck becomes uncoordinated. At exits, arching and clogging are observed.

-pedestrians spontaneously organize into lanes of uniform walking direction, if the pedestrian density is high enough.

(after Dirk Helbing, Rev. Mod. Phys. 73 (2001) 1067)

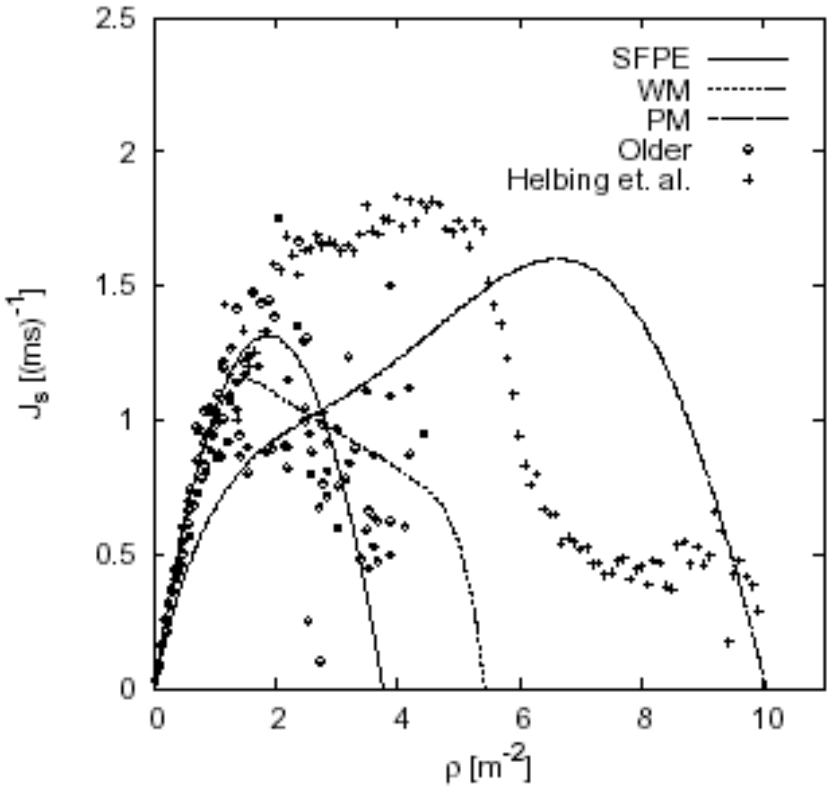
Crowd dynamics – intro 3/4 – fundamental diagrams

v



ρ

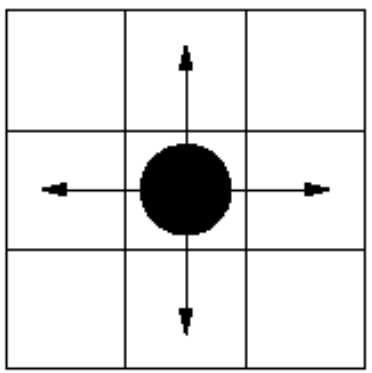
$J_s = \rho\, v$



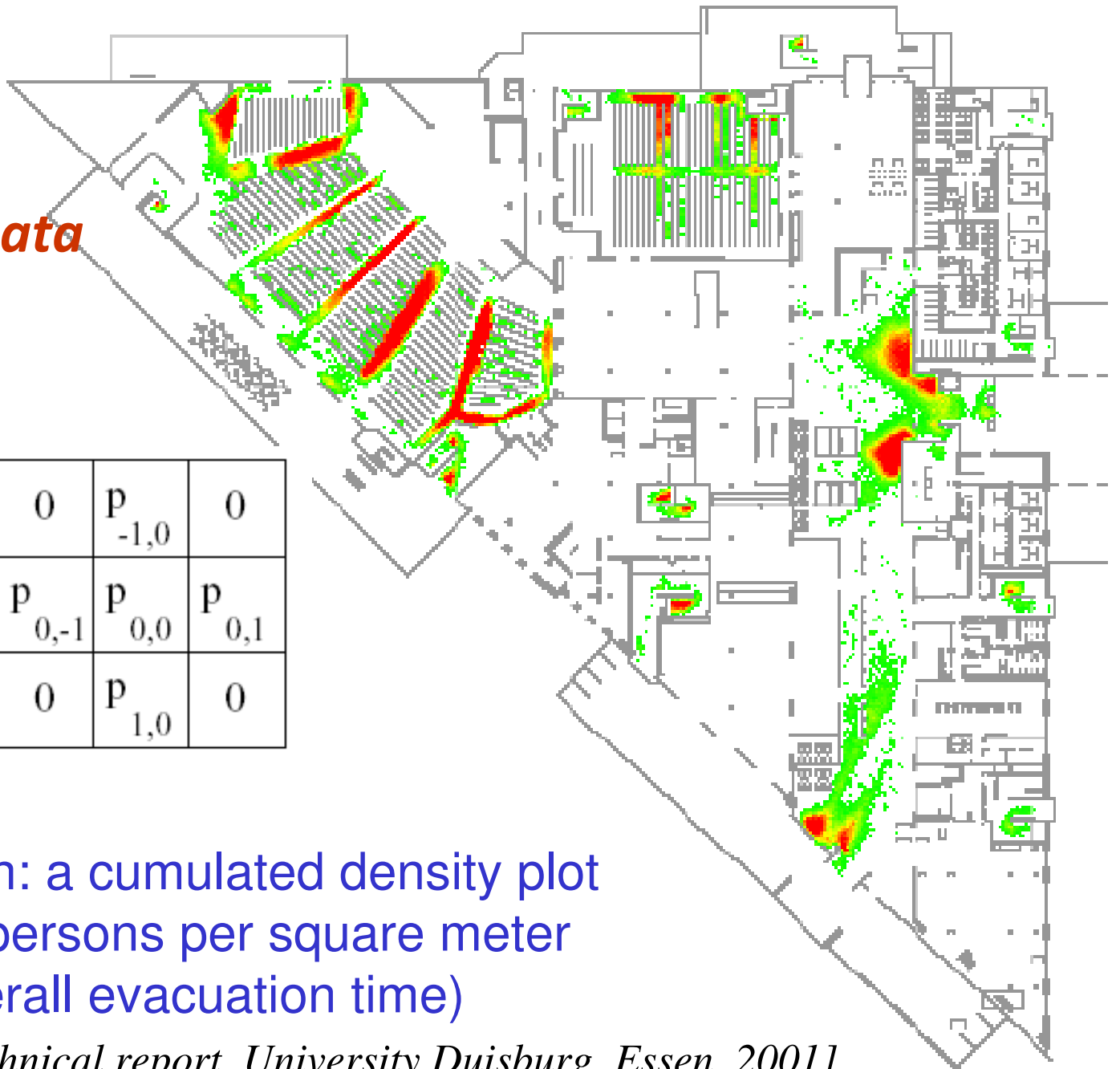
ρ

[after A. Schadschneider et al., Encyclopedia of Complexity and System Science, B. Meyers (Ed.), Springer, Berlin, 2008]

Crowd dynamics - intro 4/4 - cellular automata



0	$p_{-1,0}$	0
$p_{0,-1}$	$p_{0,0}$	$p_{0,1}$
0	$p_{1,0}$	0



Hotel evacuation: a cumulated density plot (more than 3.5 persons per square meter and 10 % of overall evacuation time)

[H. Klüpfel et al, Technical report, University Duisburg, Essen, 2001]

Generalized Force Model of self-driven particles

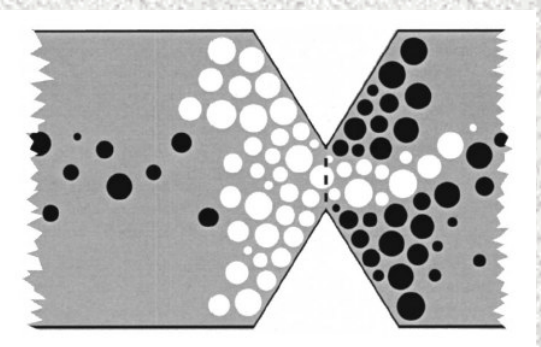
$$m\frac{d\vec{v}_i}{dt} = m\frac{\vec{v}_d(\vec{r}_i) - \vec{v}_i}{\tau} + \sum_{j(\neq i)} \vec{f}_{ij} + \sum_{w} \vec{f}_{iw}$$

where

$$\vec{f}_{ij} = \beta_j A_j \hat{r}_{ij} e^{\lambda d_{ij}} + \left\{ k\hat{r}_{ij} + \kappa\left[(\vec{v}_j - \vec{v}_i)\circ\hat{t}_{ij}\right]\hat{t}_{ij} \right\} g(d_{ij})$$

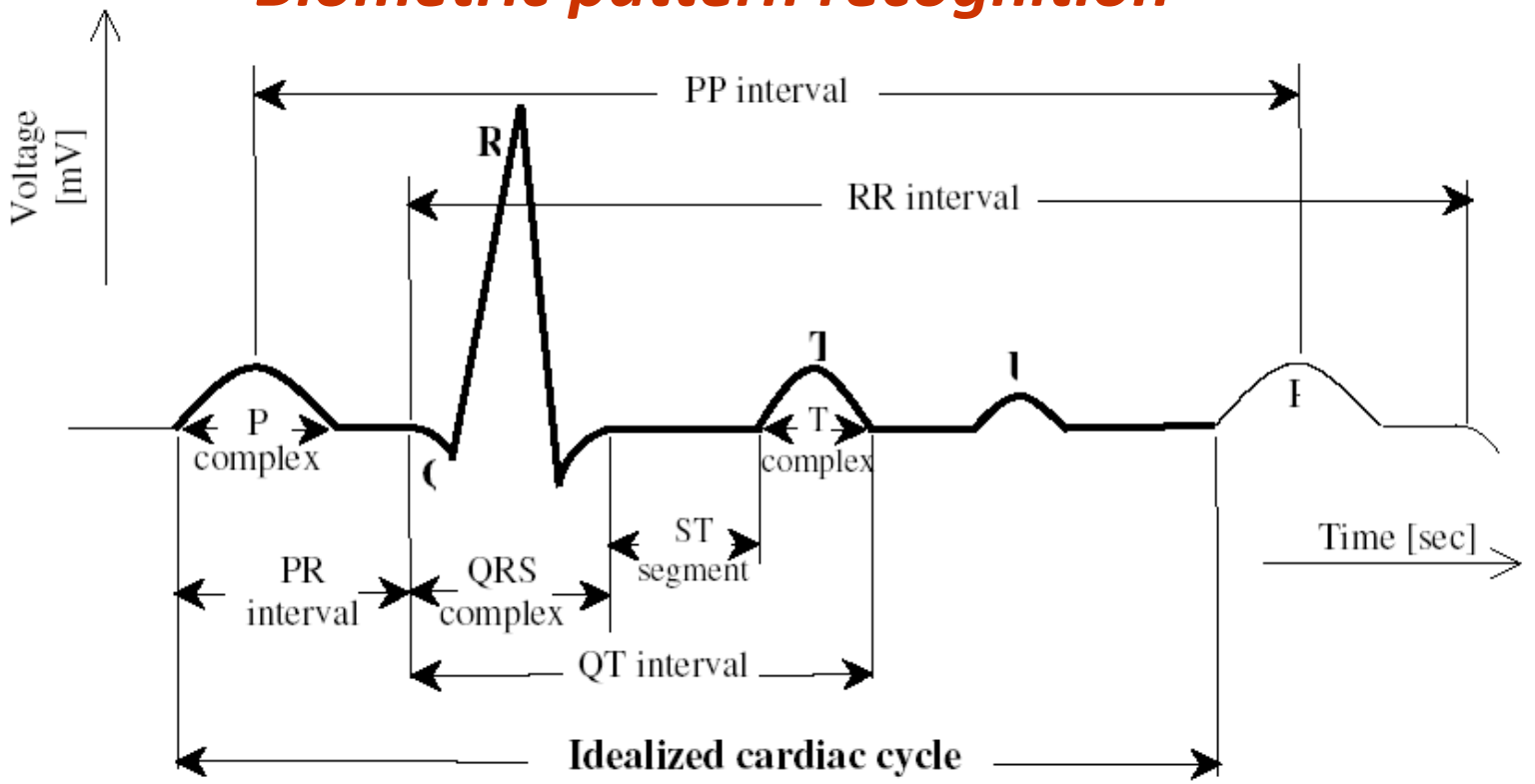
$$g(x) = \begin{cases} x & \text{if } x > 0 \\ 0 & \text{if } x < 0 \end{cases}$$

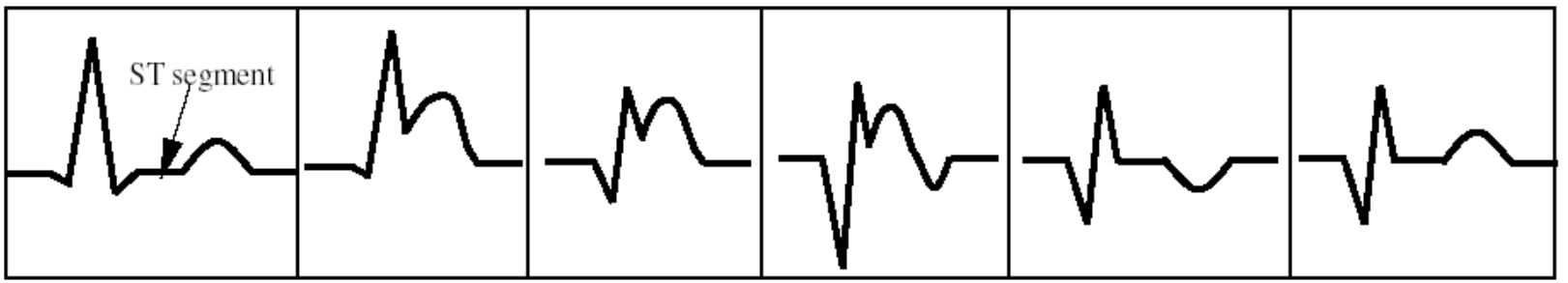
$$d_{ij} = 2R - r_{ij} \qquad \hat{r}_{ij}\circ\hat{t}_{ij} = 0$$



[after D. Helbing, I. Farkas and T. Vicsek, Nature 407 (2000) 487]

Biometric pattern recognition

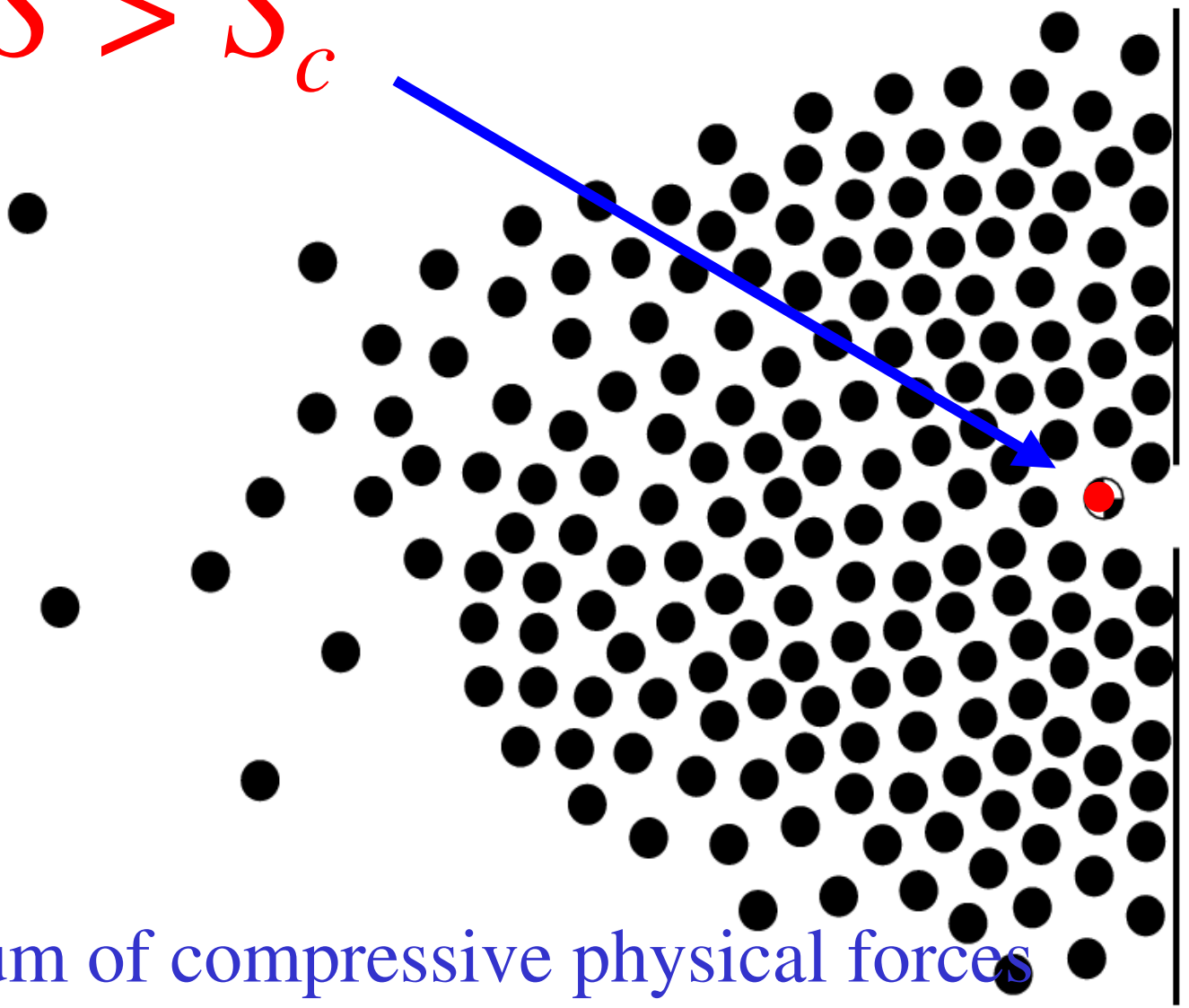




Cardiac cycle	Minutes after heart attack starts	Hours later	1-2 days	Several days	Weeks after the attack
Normal	ST shifted	- ST shifted - R dropping - Q appears to be Noticeable	- T inverted - Q goes lower	- ST normal - T inverted	- ST and T normal - Q no change

Evacuation...

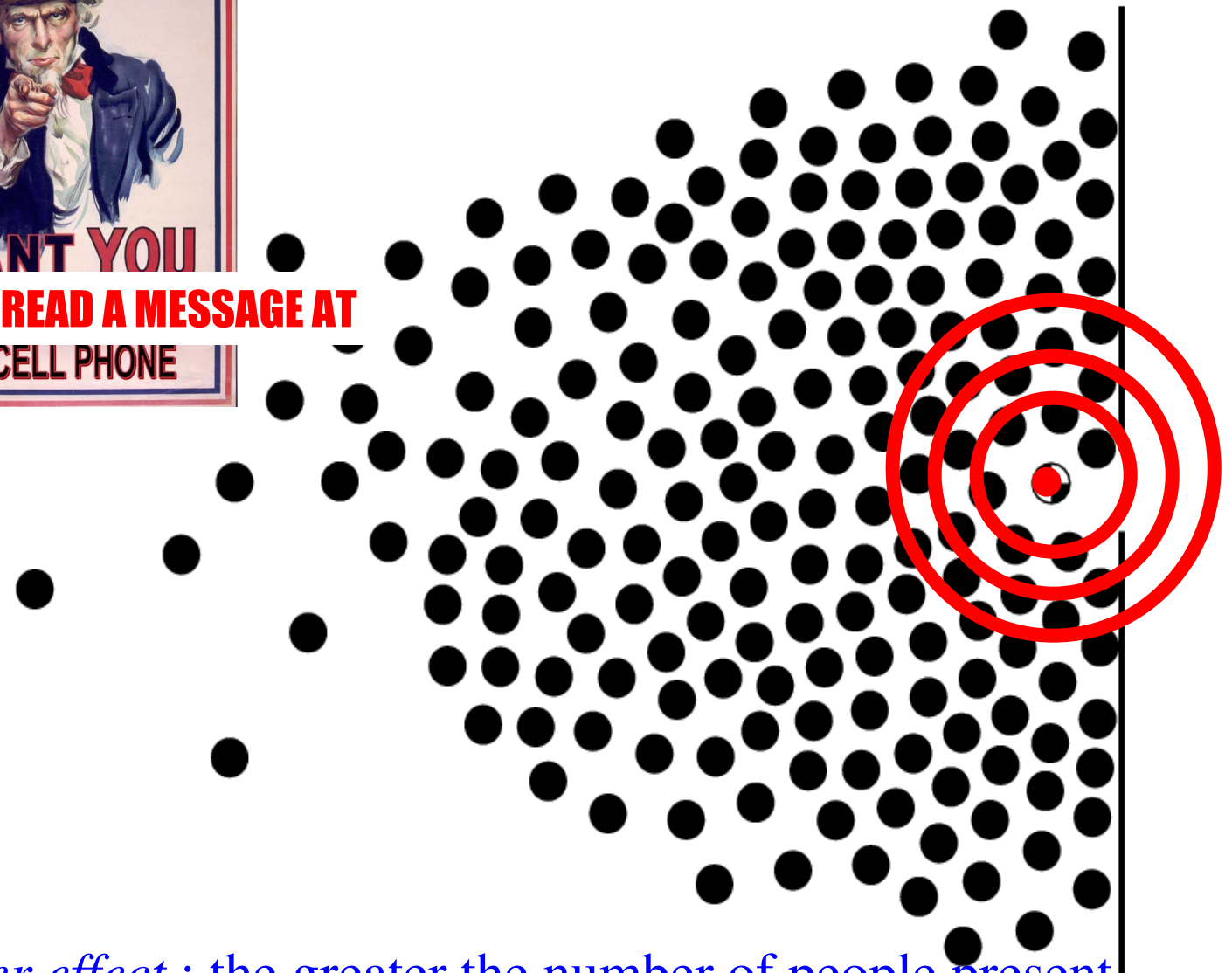
$S > S_c$



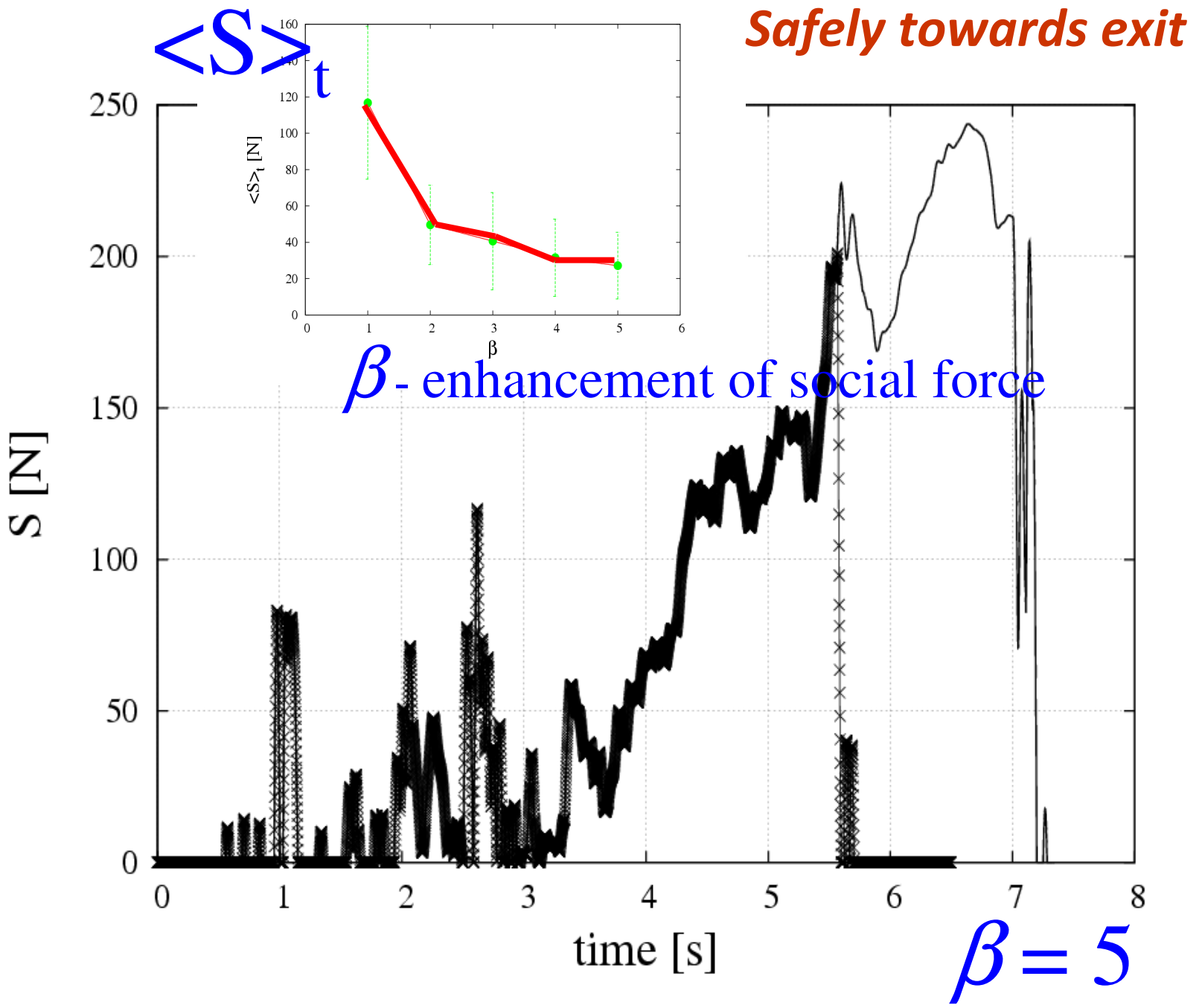
S - sum of compressive physical forces

S_c - critical value (here 200 N)

...and warning



Bystander effect : the greater the number of people present, the less likely people are to help a person in distress.


Safely towards exit
<S>t
<S>t [N]
β
β - enhancement of social force
S [N]
time [s]
β = 5

conclusions

Simulations within the Generalized Force Model show that individual responses to a call for help convert into a coherent and efficient action.

If the communication *via* Ambient Intelligence devices is registered and remains available, the bystander effect should be reduced.