About the Risk to Stick in a Traffic Jam

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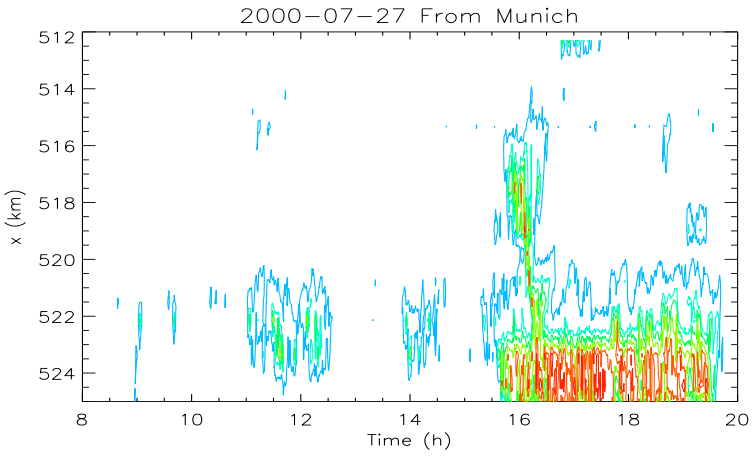
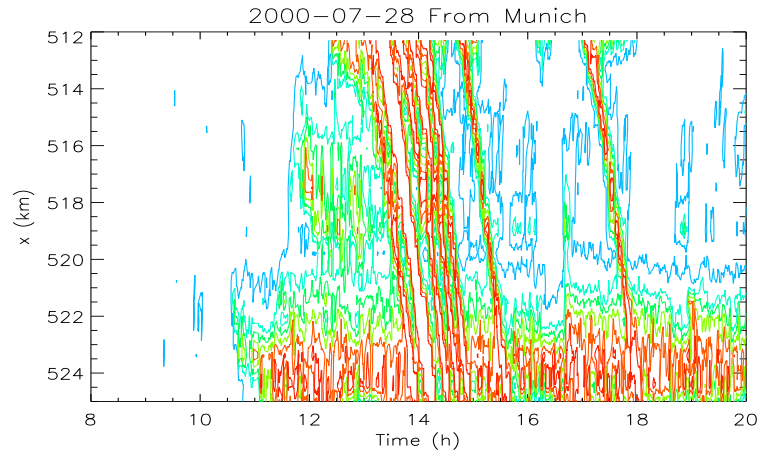
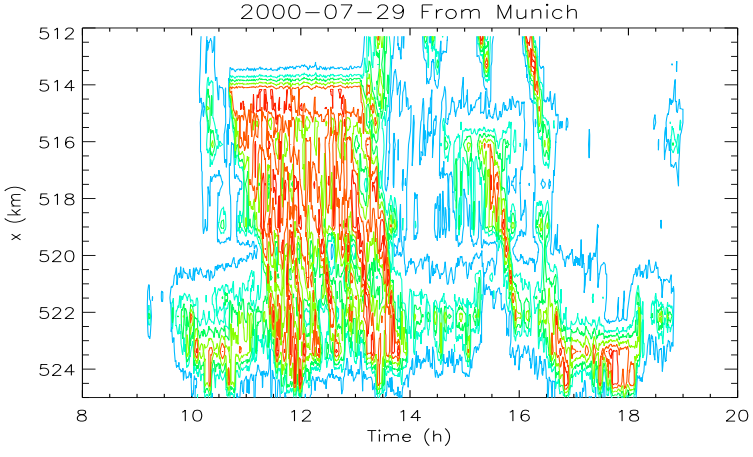
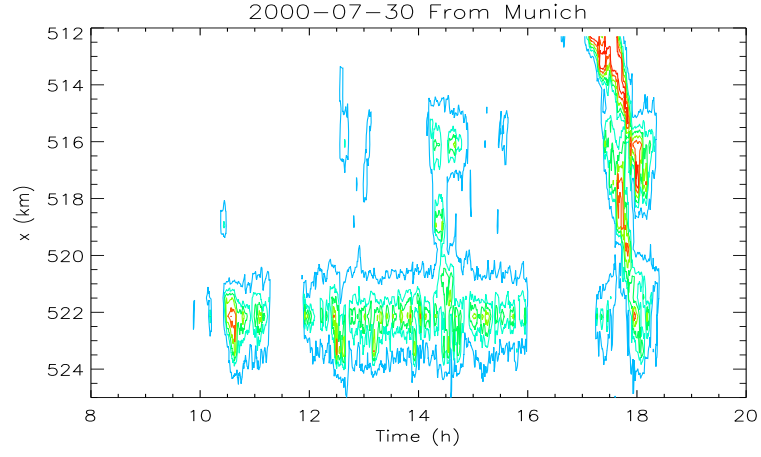
Observations: Autobahn from Munich



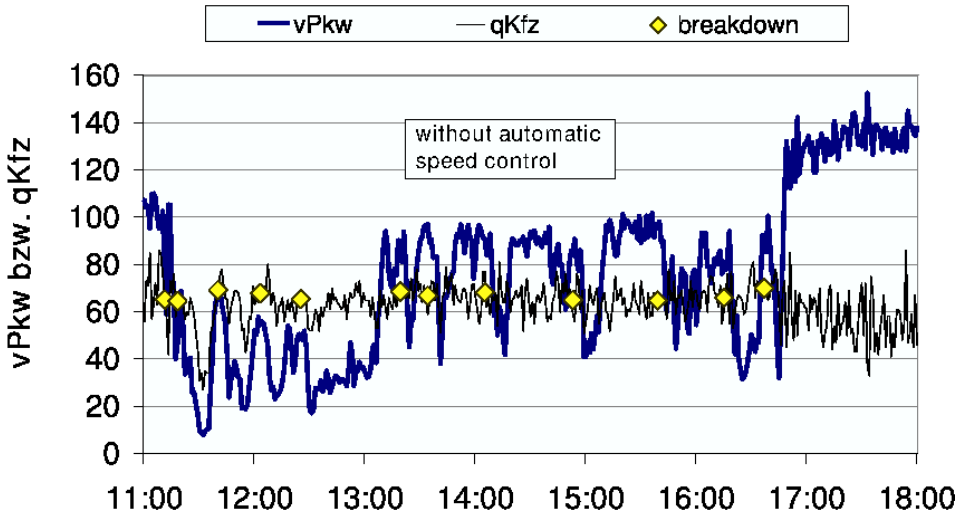


Color coded contour plots of daily speed of traffic.
Levels: 80 (blue), 60, 50, 40, 30 and 20 (red) km/h



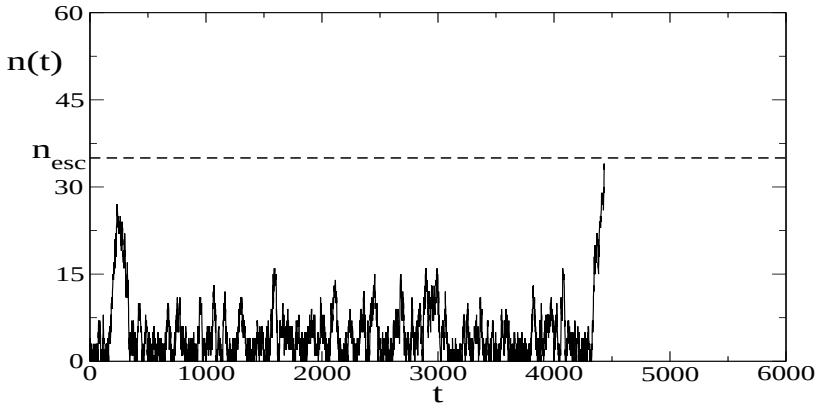


What is a traffic breakdown?

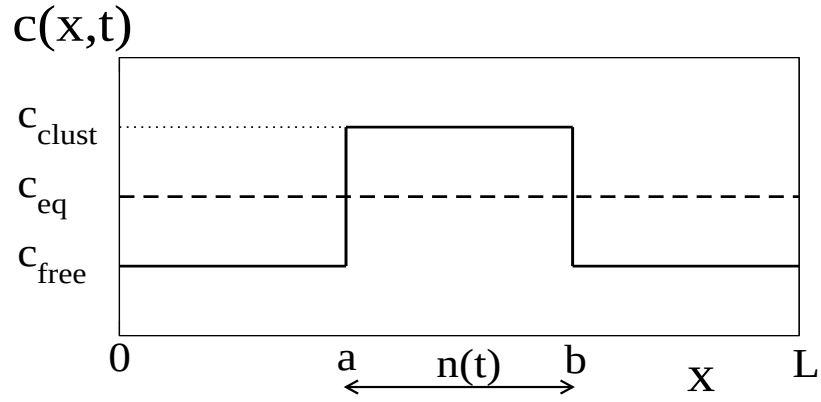


A traffic breakdown is defined (usually based on 5 minutes measurement interval data) as a

- speed drop $\Delta v > 15$ km/h
- mean velocity after speed drop $v_{final} < 75$ km/h
- traffic volume before speed drop $q > 1000$ veh/h/lane



Example of stochastic trajectory



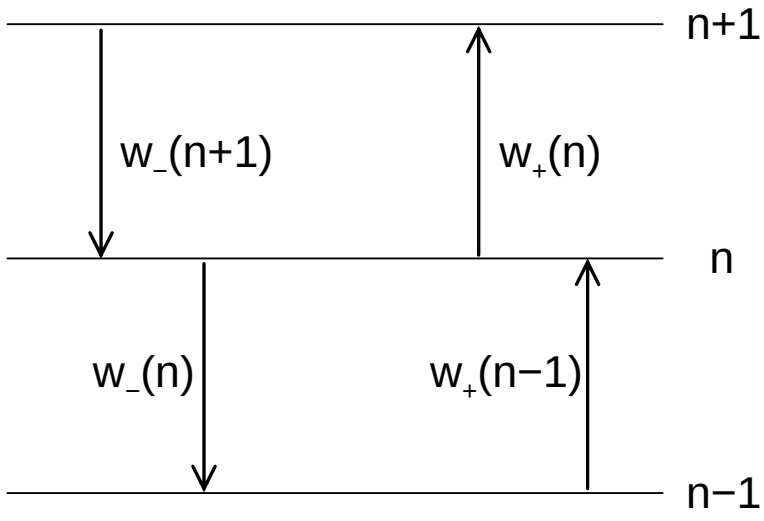
Definition of car cluster size $n(t)$

Balance equation

Stochastic master equation

number of congested vehicles: n

$$\frac{\partial P(n,t)}{\partial t} = w_+(n-1)P(n-1,t) + w_-(n+1)P(n+1,t) - [w_+(n) + w_-(n)]\,P(n,t)$$



Our car cluster model:

- inflow or attachment rate

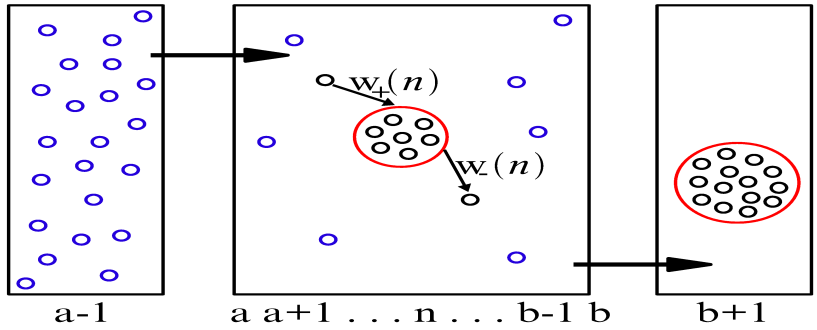
$$w_+(n) = q_{in}(n) \approx q$$

- escape or detachment rate

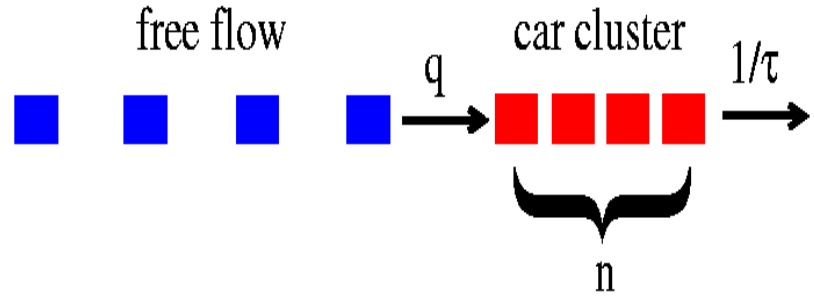
$$w_-(n) = q_{out}(n) \approx 1/\tau$$

Nucleation on highways

Probabilistic description of pattern formation:
Condensation of clusters by drift and diffusion



Nucleation reactor (Szilard model)



Vehicular channel forming jams

q [veh/h] = traffic flow or traffic volume (from net time gap for a freely moving car)

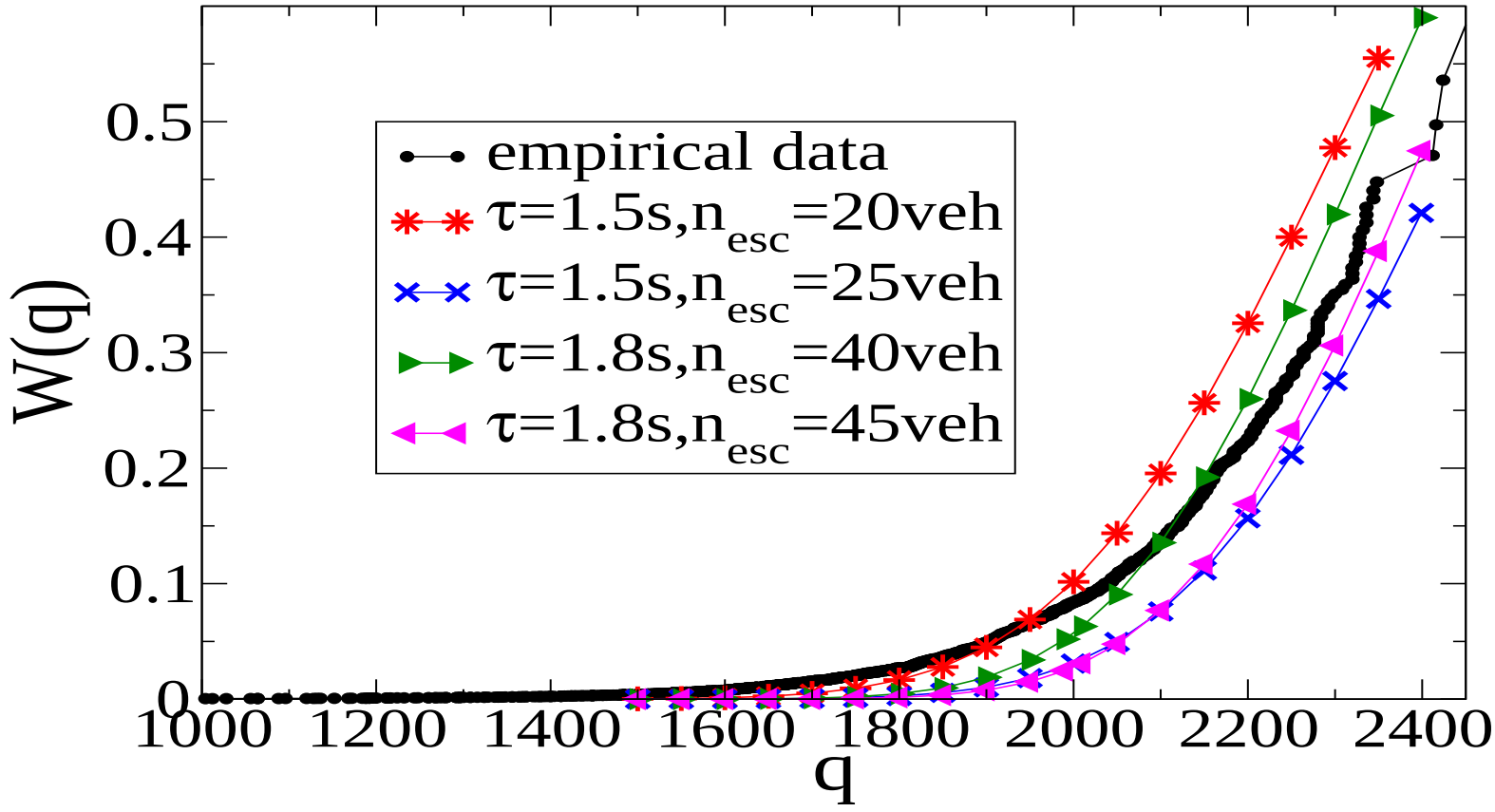
n = cluster size or queue length (number of congested vehicles) as stochastic variable

τ [$\tau \approx 1.5$ s] = characteristic time needed for the first car leaving the cluster to become free

Cumulative breakdown distribution

Defining $W(T_{obs}, q) = \int_0^{T_{obs}} \mathcal{P}(T; q)\, dT$ in relation to measurements. T_{obs} is called observation time.

Data from Regler & Brilon (Bochum, 2004) for observation time interval 5 min.



References

- *Probabilistic description of traffic breakdown* by R. Kühne, R. Mahnke et al., Physics Review E, vol. 65 (2002) 066125

- Review *Probabilistic description of traffic flow* by R. Mahnke, J. Kaupužs and I. Lubashevsky, Physics Reports, vol. 408 (March 2005), Nos. 1-2 (`http://www.elsevier.com/locate/physrep`)