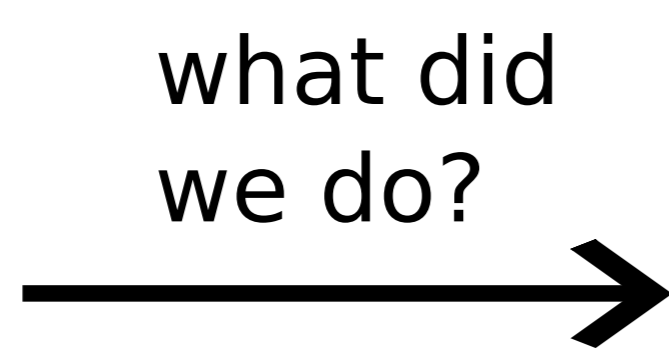


# MODELING BALL POSSESSION DYNAMICS IN THE GAME OF FOOTBALL

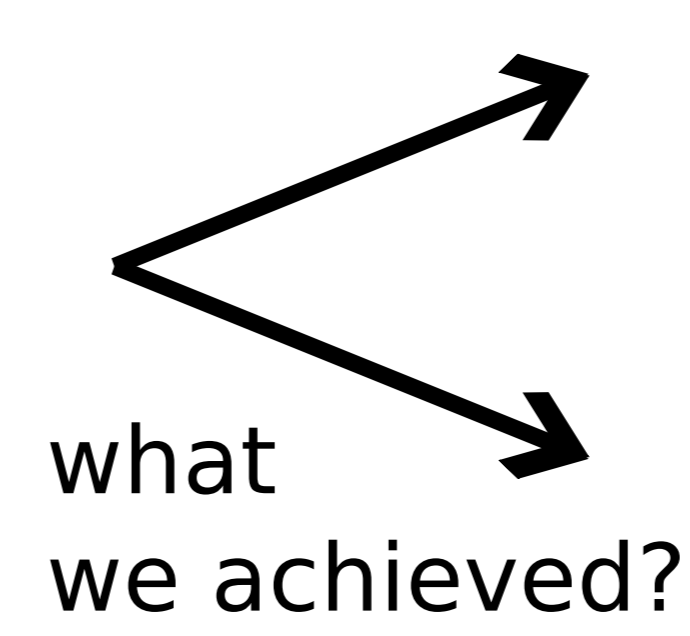
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Our object of study:  
**Ball possession intervals**



Surveyed a big football-events database and found statistics patterns.

With this, we Proposed a model for the ball possession dynamics.



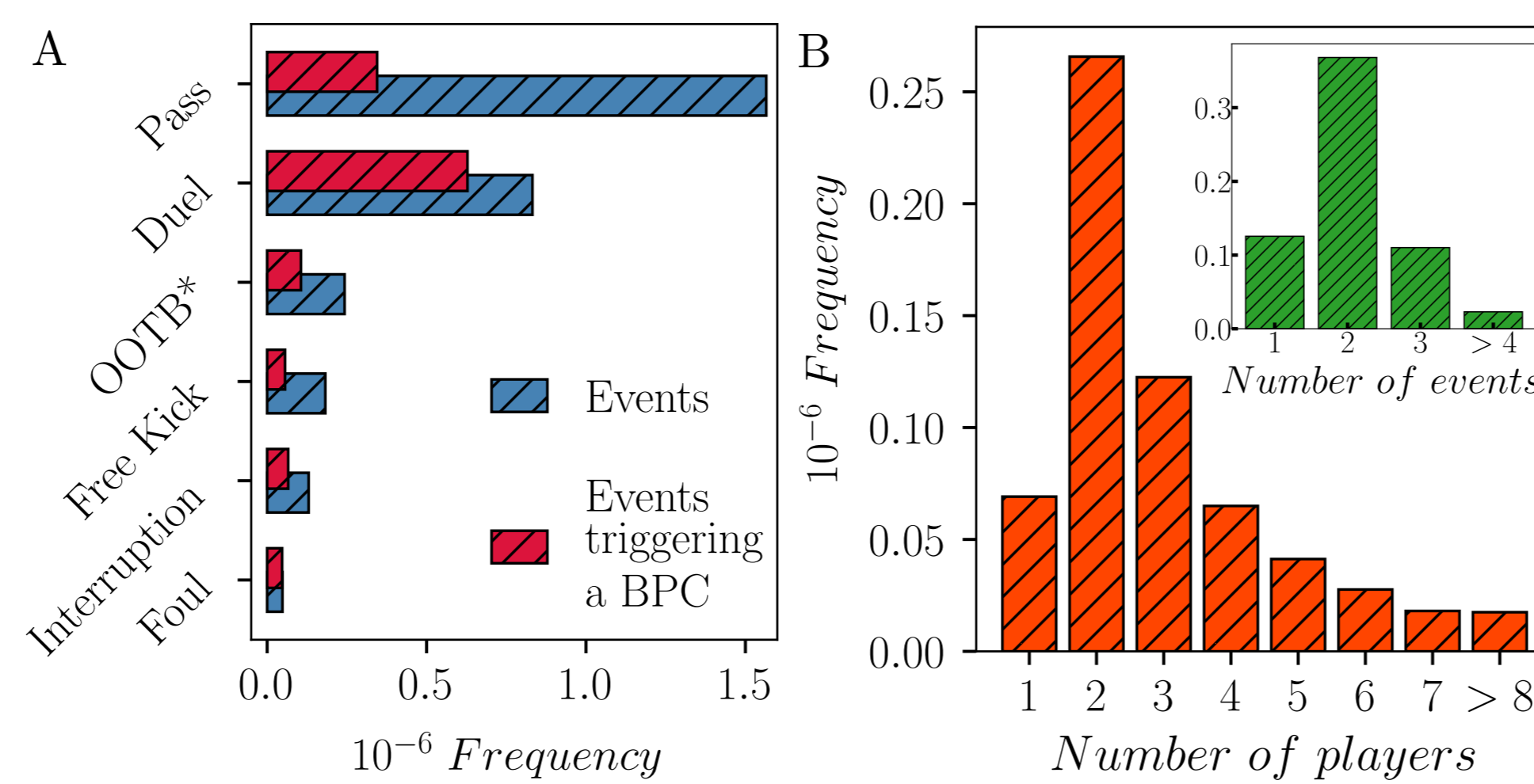
Successfully compared the model outcomes with the empirical data (possession times, passes lengths, and number of passes performed)

Showed the model's dynamics can be mapped into a Wiener process with drift and an absorbing barrier.

## Statistical patterns + Modeling

1 - GLOBAL CHARACTERIZATION  
Analysis of an extensive database (1826 games / 625 195 intervals)  
[Pappalardo et al (2019)]

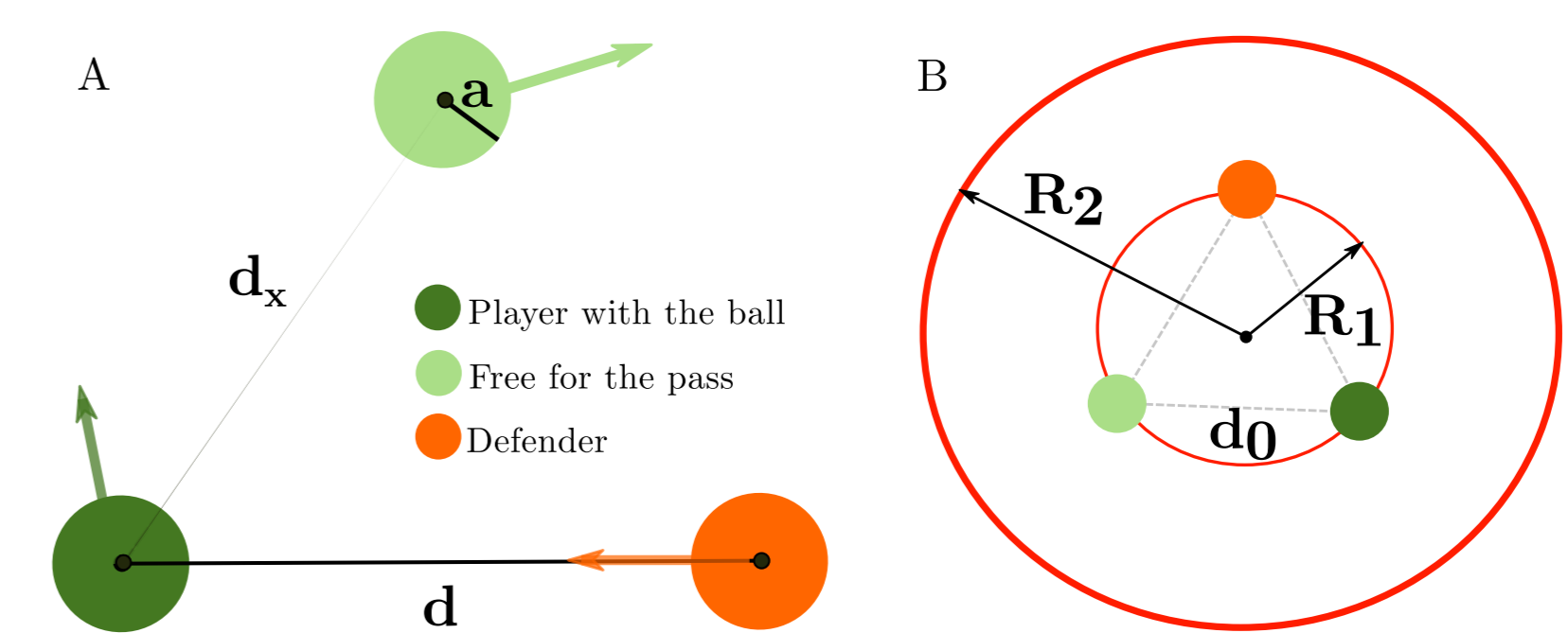
- \* The number of events per intervals is little.
- \* Few players involved.
- \* Most frequent event: PASS.
- \* Most frequent event that produces a possession change: DUEL



## 2 - MODELING

A simplified game

- \* 3 Players → 2 Companions / 1 Defender
- \* Behavioral rules by player
- \* The defender chases the ball.
- \* There may be passes between teammates
- \* The interval ends when the defender reaches the one with the ball.

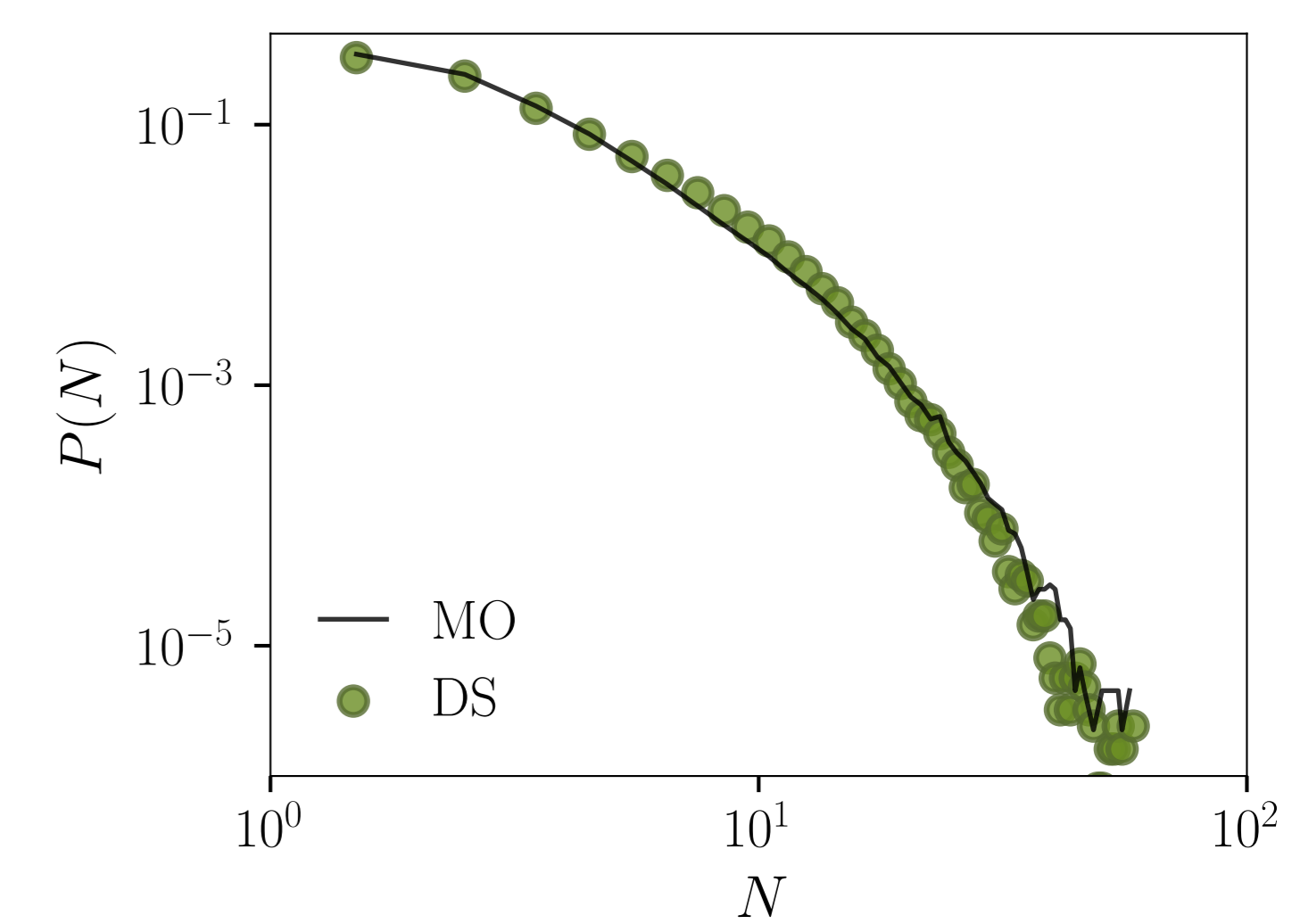
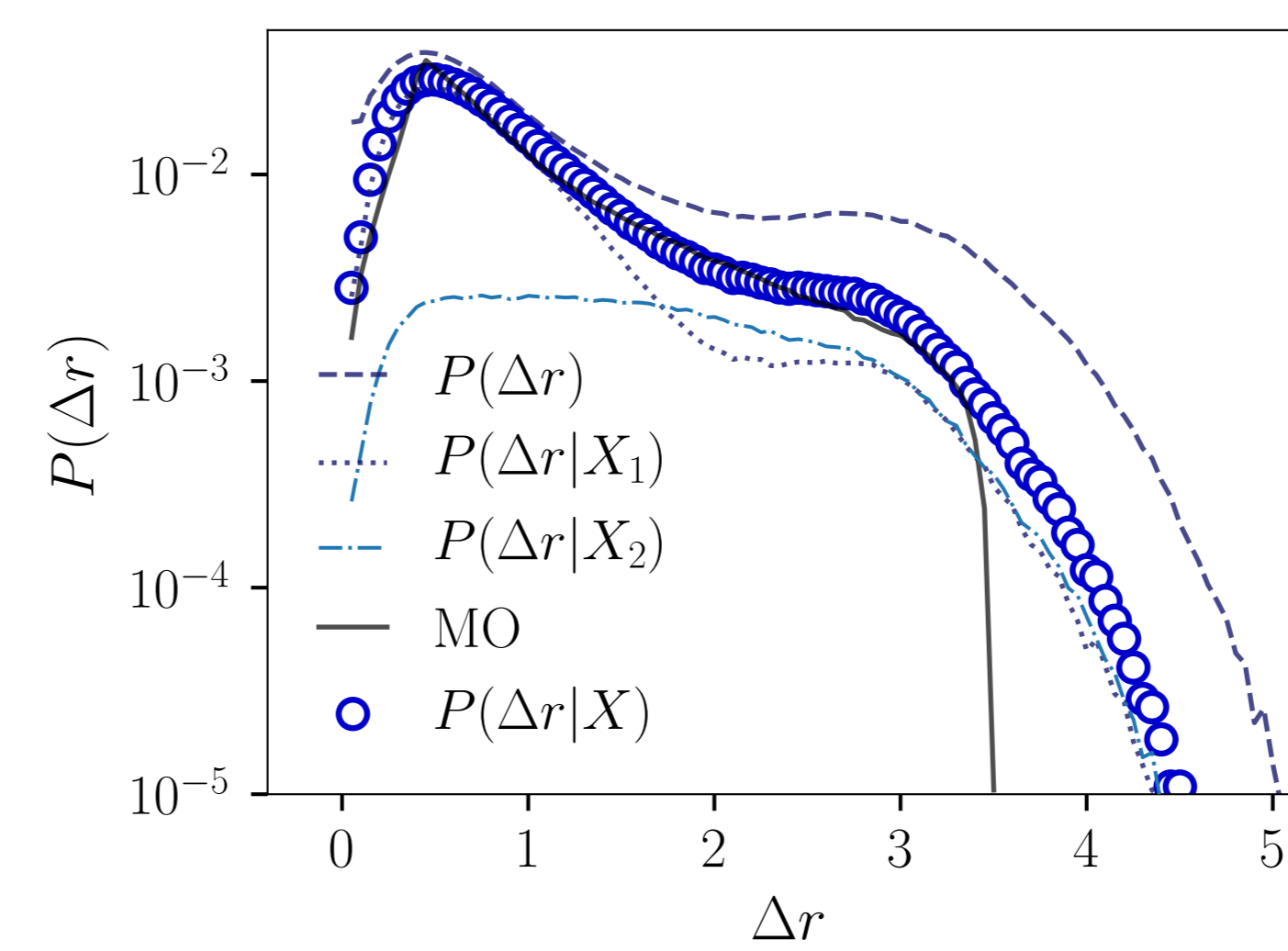
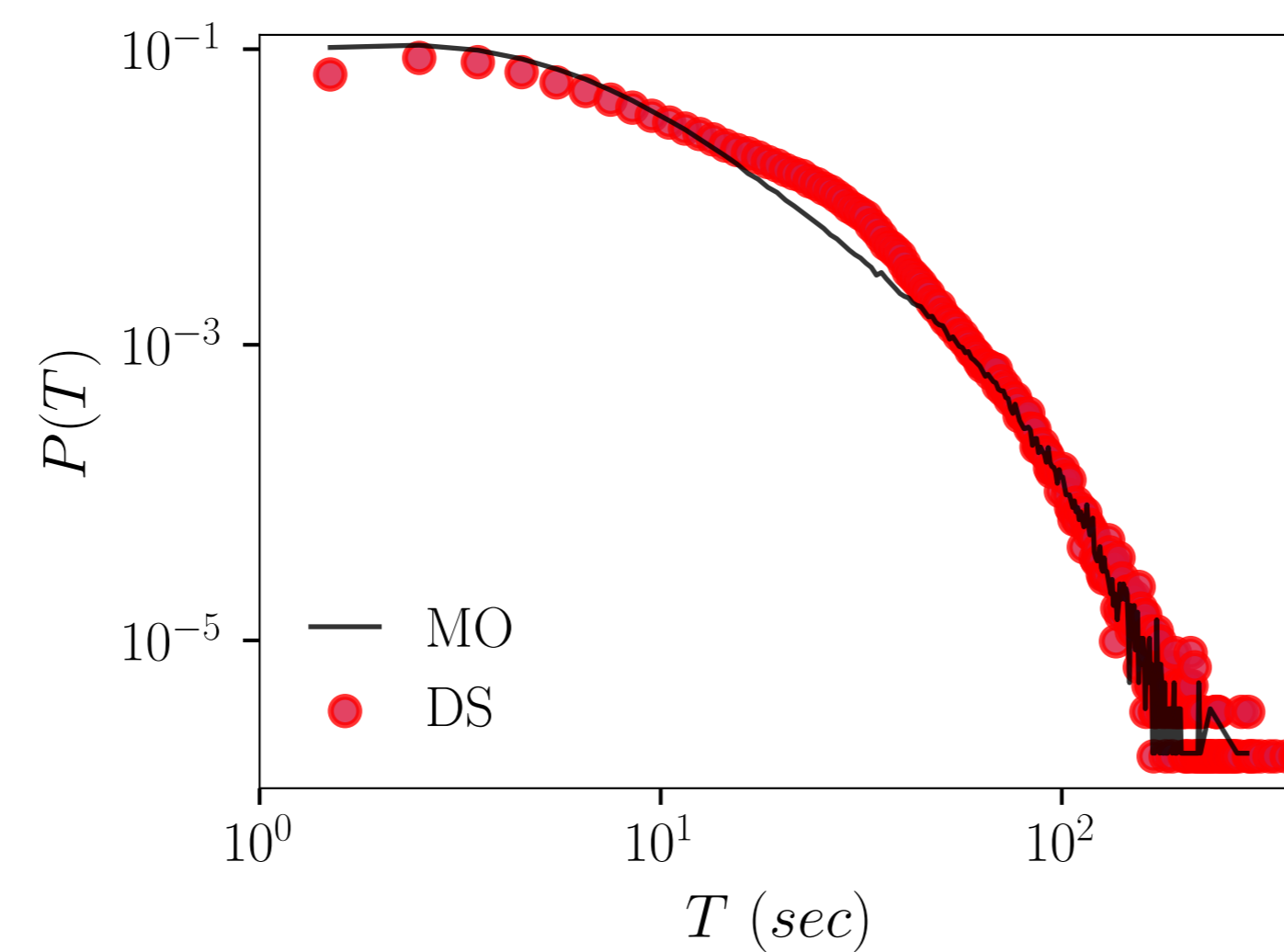


## Assessing the model performance

We fit the model's parameters using three distributions:

- $P(T)$  possession time,
- $P(\Delta r)$  passes length,
- $P(N)$  number of passes

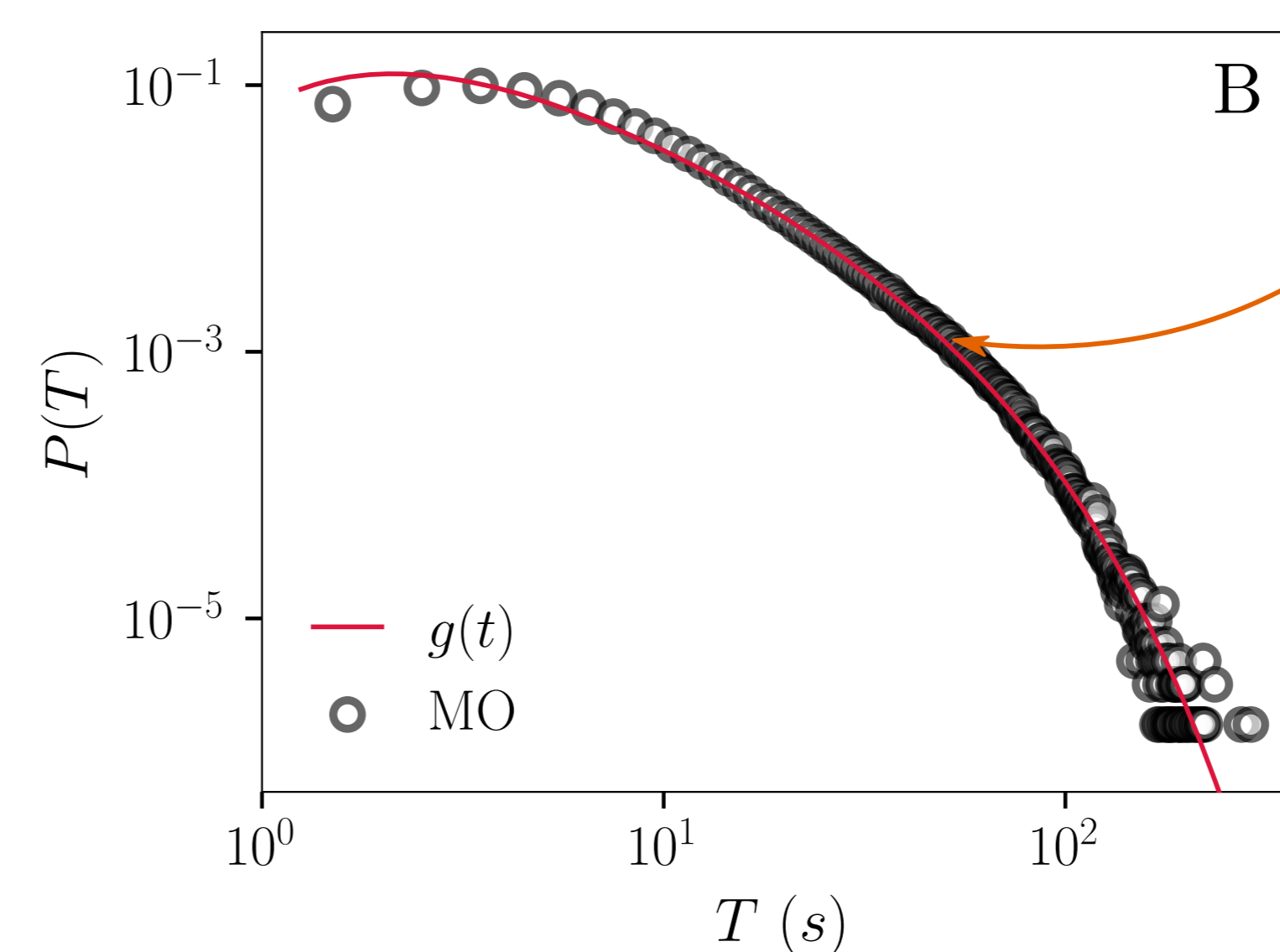
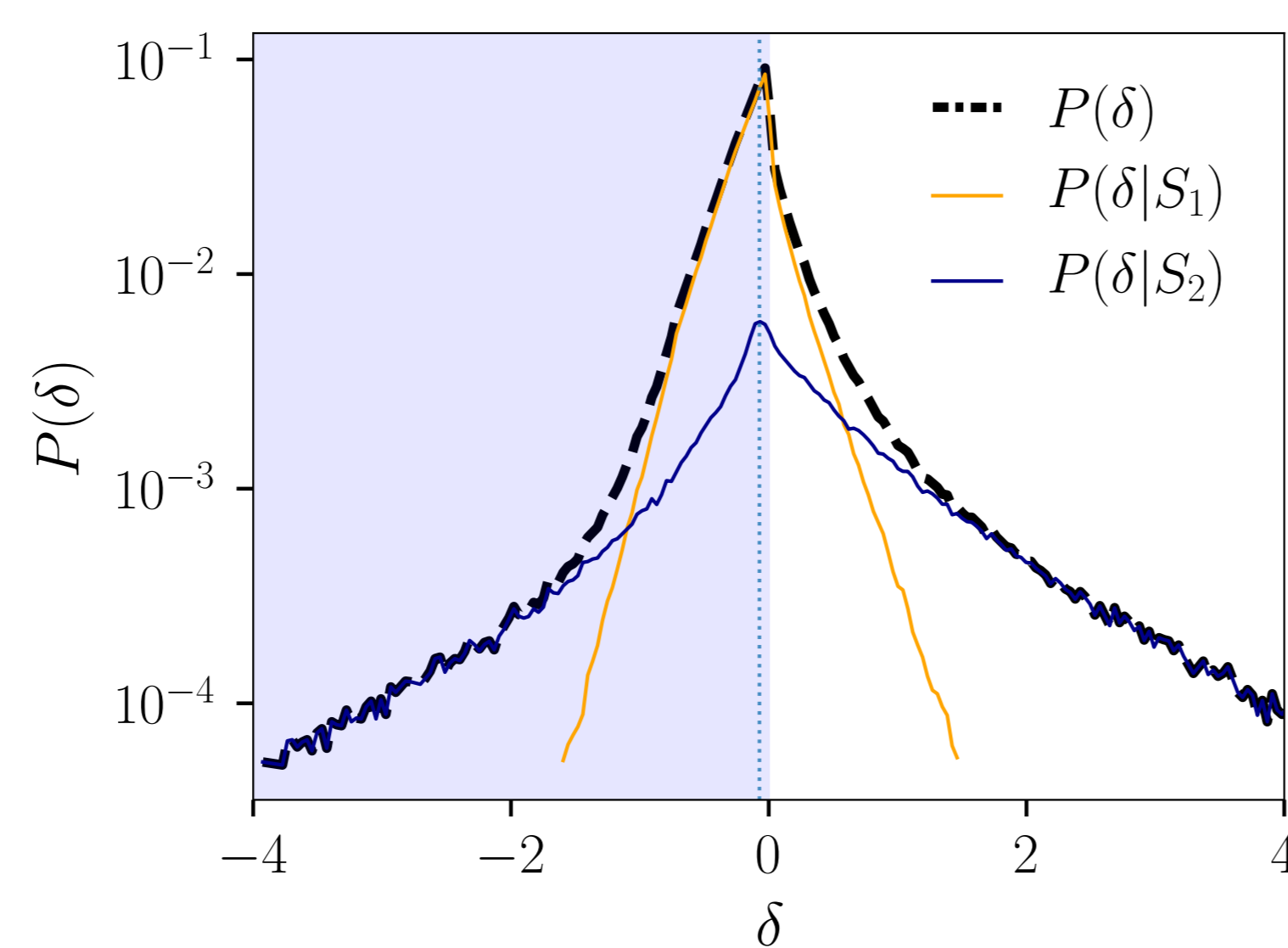
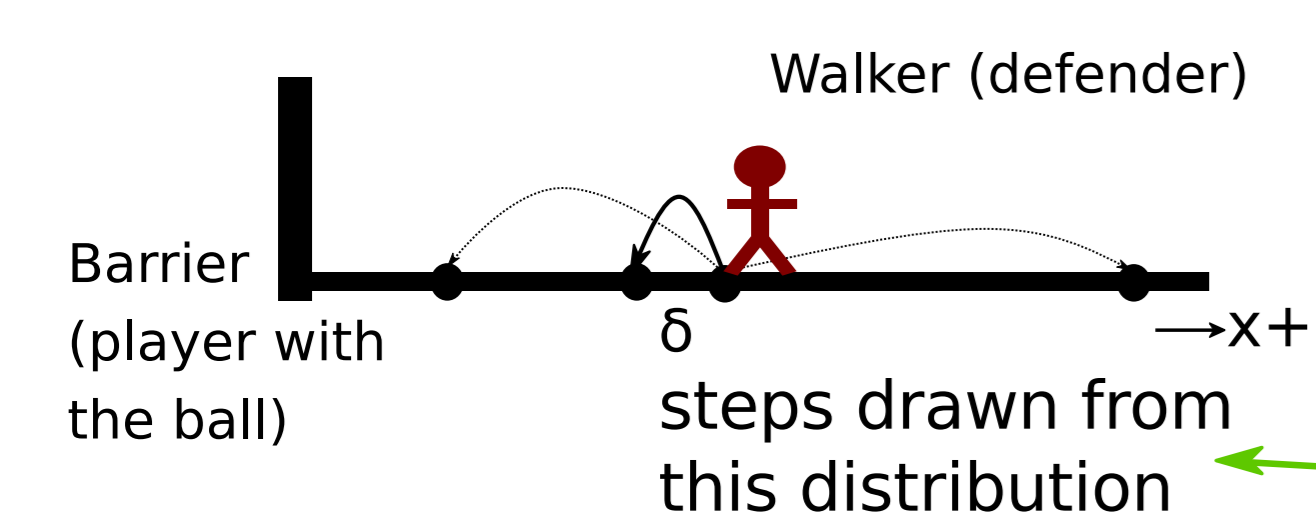
We observed that the model captures very well global aspects of the empirical observables.



## Mapping the model in a theoretical framework

The system can be seen from the frame of reference of the ball position.

1D random walk with variables steps and drift towards an absorbing barrier.



$$g(\tau) = \frac{x_b}{\sigma \sqrt{2\pi\tau^3}} \exp\left(-\frac{(x_b - \mu\tau)^2}{2\sigma^2\tau}\right)$$

We observed that the First Passage Time equation,  $g(\tau)$ , fits very well the probability  $P(T)$

## Summary and perspectives

We study interaction dynamics in the game of football-soccer in the context of ball possession intervals. To do so, we analyze a database comprising one season of the five major football leagues of Europe. Using this input, we developed a stochastic model based on three agents: two teammates and one defender. Despite its simplicity, the model is able to capture, in good approximation, the statistical behavior of possession times, pass lengths, and the number of passes performed. Moreover, we show that the model's dynamics can be mapped into a Wiener process with drift and an absorbing barrier.

Currently, we are studying collective interaction dynamics analyzing body-sensor traces measured during professional football games (\*).

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Link to the paper

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New contribution in football analytics (\*)"Stochastic model for football's collective dynamics"

DOI: 10.1103/PhysRevE.104.024110