Projecte de Treball Fi de Màster (TFM)

Màster en Modelització Computacional Atomística i Multiescala en Física, Química i Bioquímica
UB/UPC

Títol	**Modelització d'efectes cooperatius en la dinàmica de grups d'animals**
Title	**Modelling cooperative phenomena in the dynamics of animal groups**

Director	**María del Carmen Miguel López** **Romualdo Pastor Satorras**
Departament	**Departament de Física Fonamental** **Departament de Física**
Universitat	**Universitat de Barcelona** **Universitat Politècnica de Catalunya**
Tutor[1]	

Curs	**2015-16**

Summary[2]

Many laws in nature appear to have a common statistical origin. There are, for instance, many realizations of the spontaneous emergence of order from disorder in natural systems, i.e. in systems formed by living constituents, very much like it occurs in traditional physical systems made out of inert particles. In this project we propose to investigate the emergence of cooperative phenomena reported in recent experiments about the dynamics of social animal groups. We will address the general questions of whether such groups are able to achieve a consensus, and how it happens, starting from heterogeneous conditions and assuming several types of relationships. The pathway of communication among animals might not always have a physical form, and thus when modelling these systems we will try to incorporate and elucidate the importance of other ingredients, such as sensory information, or the role of leadership, that can help animals to track more efficiently their complex environment.

Keywords[3]	Animal behaviour, cooperative phenomena, fluctuations, phase transitions

Breu descripció del projecte[4]

The methodology of Statistical Physics has proven to be very useful to describe phenomena in several disciplines that in the past where considered outside its own scope. In recent years, physicists are studying the collective phenomena emerging from social interactions, interactions between individuals considered as elementary units in a large social structure. Without interactions, heterogeneity dominates, each individual would follow its own will. On the contrary, interactions lead to a certain degree of homogeneity. Indeed, human societies are characterized by certain degree of order and regularity: shared opinions or political ideologies, the adoption of a common language, etc. Likewise, the cooperative behavior of vast animal groups, such as the one observed in migratory movements, is quite intriguing. As an example we could mention that, after hours or even days of individualistic behavior with no semblance of order, one wildebeest in the Serengeti would start moving in order to go to green pastures, and all of a sudden hundreds of wildebeest start migrating, following one after the other headed in the same direction, seeing no further than the one right in front of them.

In this research project we plan to investigate the emergence of cooperative phenomena reported in recent experiments about the dynamics of social animal groups. We will address the general questions of whether such groups are able to achieve a consensus, and how this cooperation comes about, starting from heterogeneous conditions, using various types of communication rules (chasing, alignment, etc.), and assuming several types of topologies to account for the plausible relationships within the animal group. In watching different kinds of animal interactions it appears evident that some sort of leadership style is being utilized. We also plan to analyze the influence of different leading strategies on the collective outcome.

References:

[1] I.D. Couzin *et al*., Journal of Theoretical Biology **218**, 1 (2002).
[2] I.D. Couzin *et al*., Nature 433, 513 (2005).
[3] C. Castellano, S. Fortunato and V. Loreto, Rev. Mod. Physics **81**, 591 (2009).
[4] I.D. Couzin *et al*., Science **334**, 1578 (2011).
[5] N.W.F. Bode, A.J. Wood, D.W. Franks, Animal Behavior **82**, 29 (2011).

Competències addicionals[5] (opcional)

Tasques a desenvolupar[6]		**Cronograma** (setmanes)																	
Tasca	**Descripció**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
T01	**Recerca bibliogràfica (aprox. 50 h)**	X	X	X			X											X	
T02	**Adquisició de conceptes teòrics bàsics (aprox. 40 h)**		X	X	X	X													
T03	**Proposta de models de comportament dinàmics (aprox. 60 h)**				X	X	X	X	X										
T04	**Programació i exploració preliminar dels diferents models proposats (aprox. 60 h)**							X	X	X	X	X							
T05	**Simulació exhaustiva dels models (aprox. 80 h)**										X	X	X	X	X				
T06	**Anàlisis dels resultats obtinguts (aprox. 60h)**											X	X	X	X	X			
T07	**Racionalització i interpretació física dels resultats (aprox. 60h)**												X	X	X	X	X		
T08	**Redacció de la memòria i preparació de l'exposició (aprox. 40h)**																X	X	X
T09																			
T10																			

Observacions i comentaris
Per a la realització del treball pròpiament dit es preveu una dedicació d'unes quatre hores diàries durant cinc dies a la setmana, amb la opció de modificació de l'horari per poder adaptar-se millor a l'horari acadèmic de l'estudiant. **Comentari: Recordeu que el TFM son 18 ECTS=18*25=450 hores de dedicació de l'estudiant (un 20% han de ser tutelades pel director). Calculeu 18-20 setmanes de març a juny (inclosos) per fer totes les tasques (inclosa la redacció de la memòria).**

Signatura (el director del TFM)

María del Carmen Miguel López

Professora Agregada de Física de la Matèria Condensada

Signatura (el tutor del TFM, si s'escau)