the spectacular play of starling aerobatics take place in southern Denmark two times every year when the starlings migrate to and from their breeding and winter quarters respectively.

having fouraged during the day in groups of 10-15 birds they meet up at dusk to form flocks of up to 500,000 individuals before settling down to roost in the marshes.

our investigations cover the starlings (sturnus vulgaris), from the physiology of the individual starling to the relationship between the birds that make up a flock performing black sun.

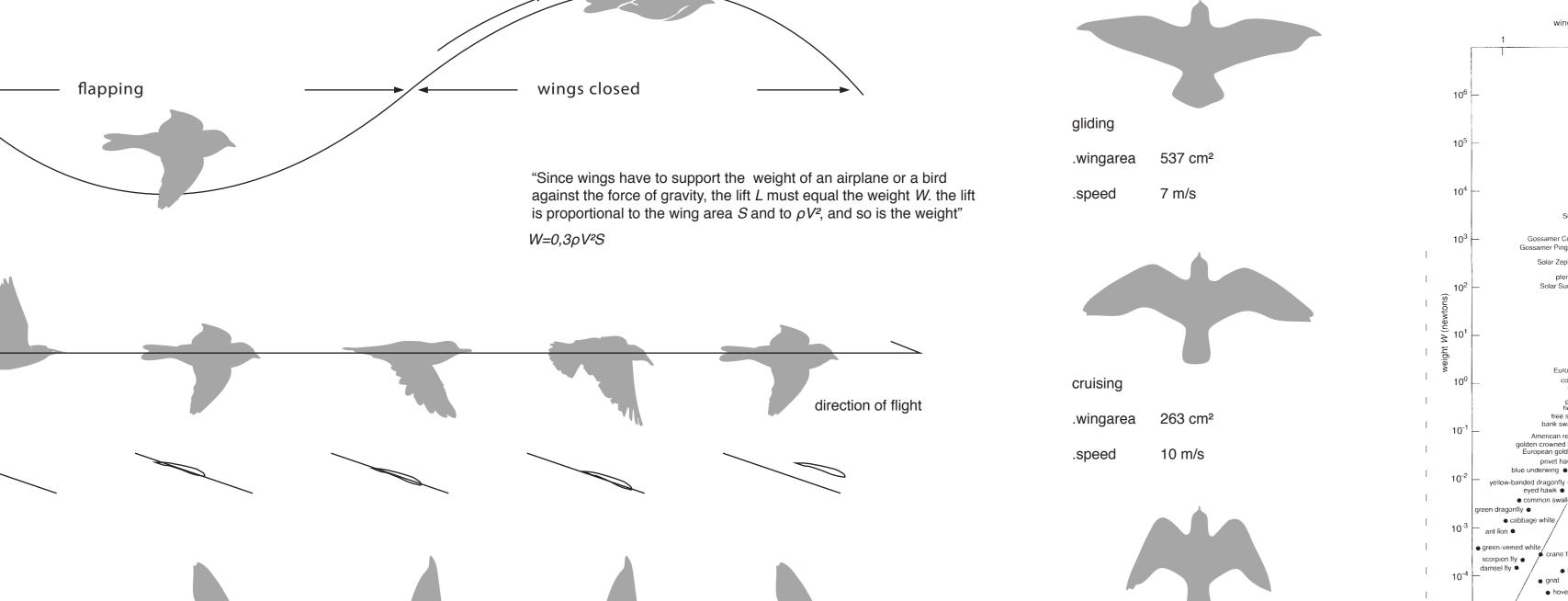
we have chosen to bracket our system as the flock performing black sun. therefore we've tried to sort out the variables and parameters of the flock as a prelude to trying to analyse their movements and recreate them, at some point, in rhino with the

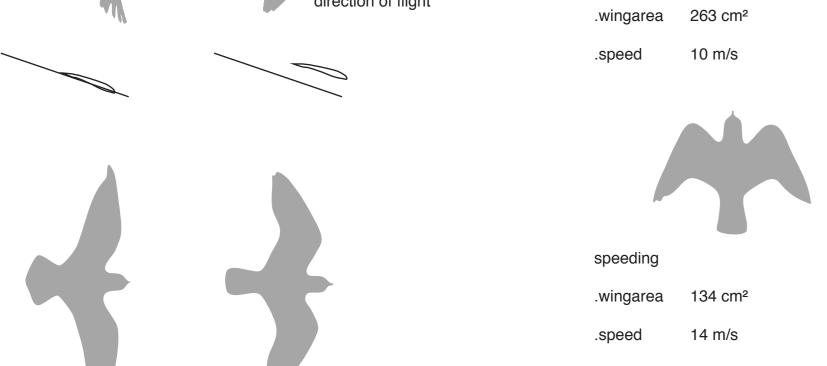
our research has Ballerini M, Cabibbo N, Candelier R, Cavagna A, Cisbani E, Giardina I, Lecomte V, Orlandi A, Parisi G, Procaccini A, et al. Interaction ruling animal collective behaviour depends on topological rather than metric distance: evidence from a field study. Proc Natl Acad Sci 2008a;105:1232-1237

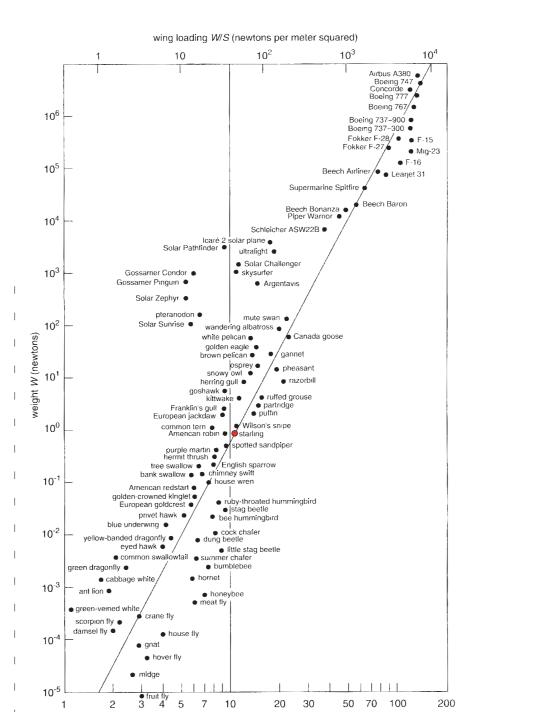
The top diagram was created to support and provide a physical reference to the data shown in the PNAS ellipsoid diagram at the



"Since wings have to support the weight of an airplane or a bird against the force of gravity, the lift L must equal the weight W. the lift is proportional to the wing area S and to ρV^2 , and so is the weight" wing track





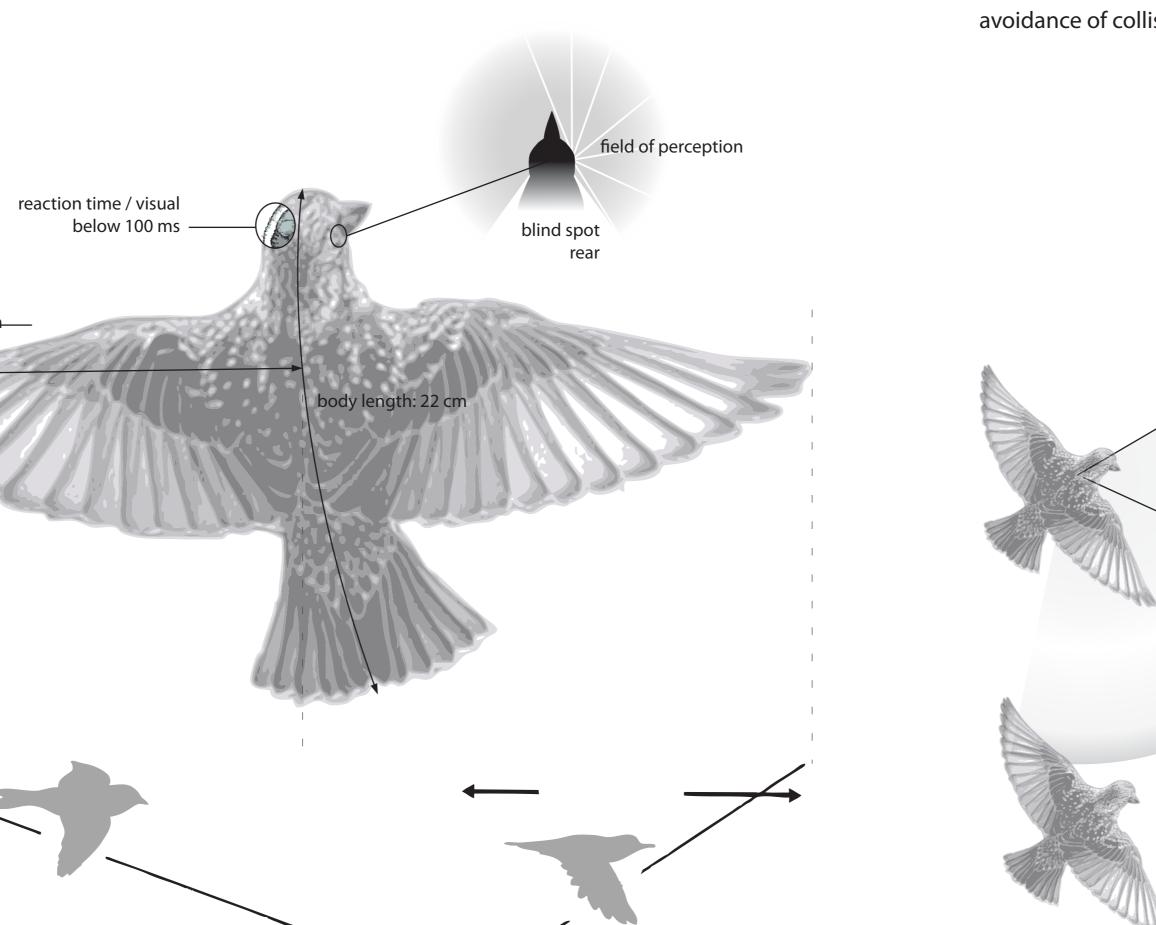


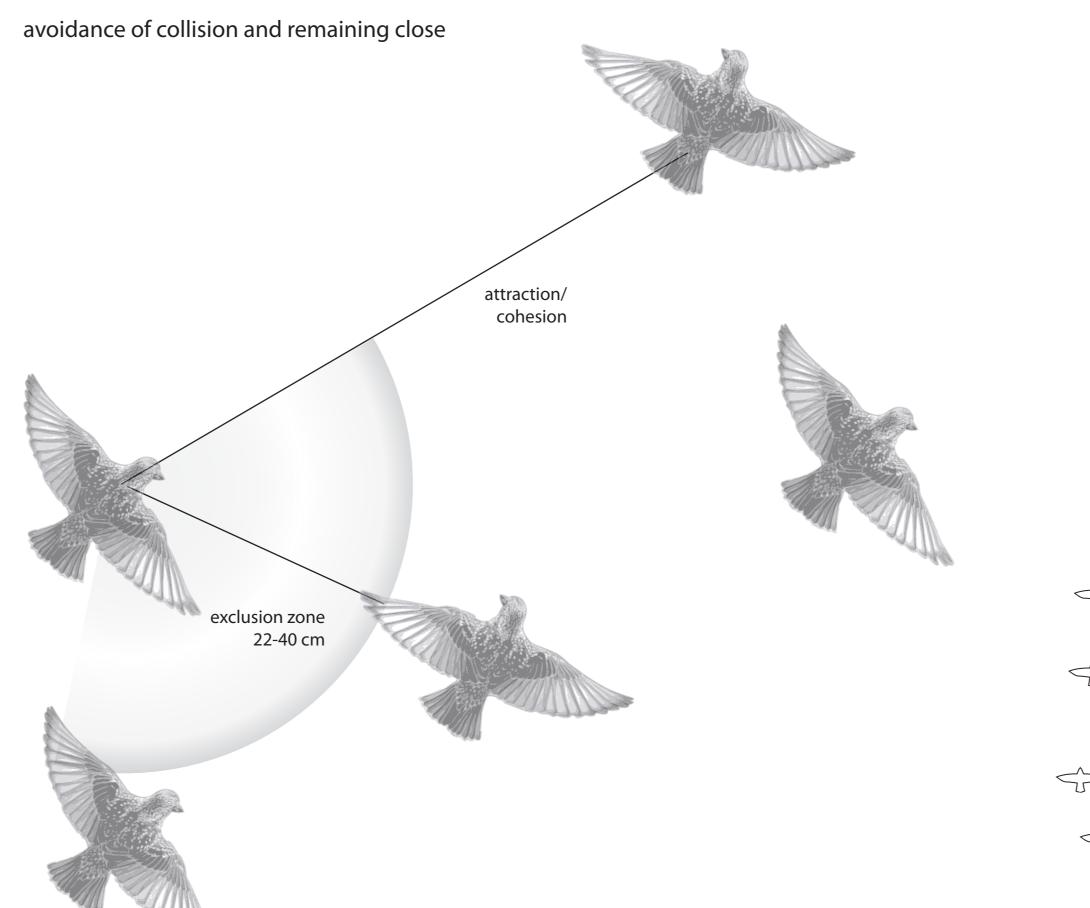
cruising speed V (meters per second)

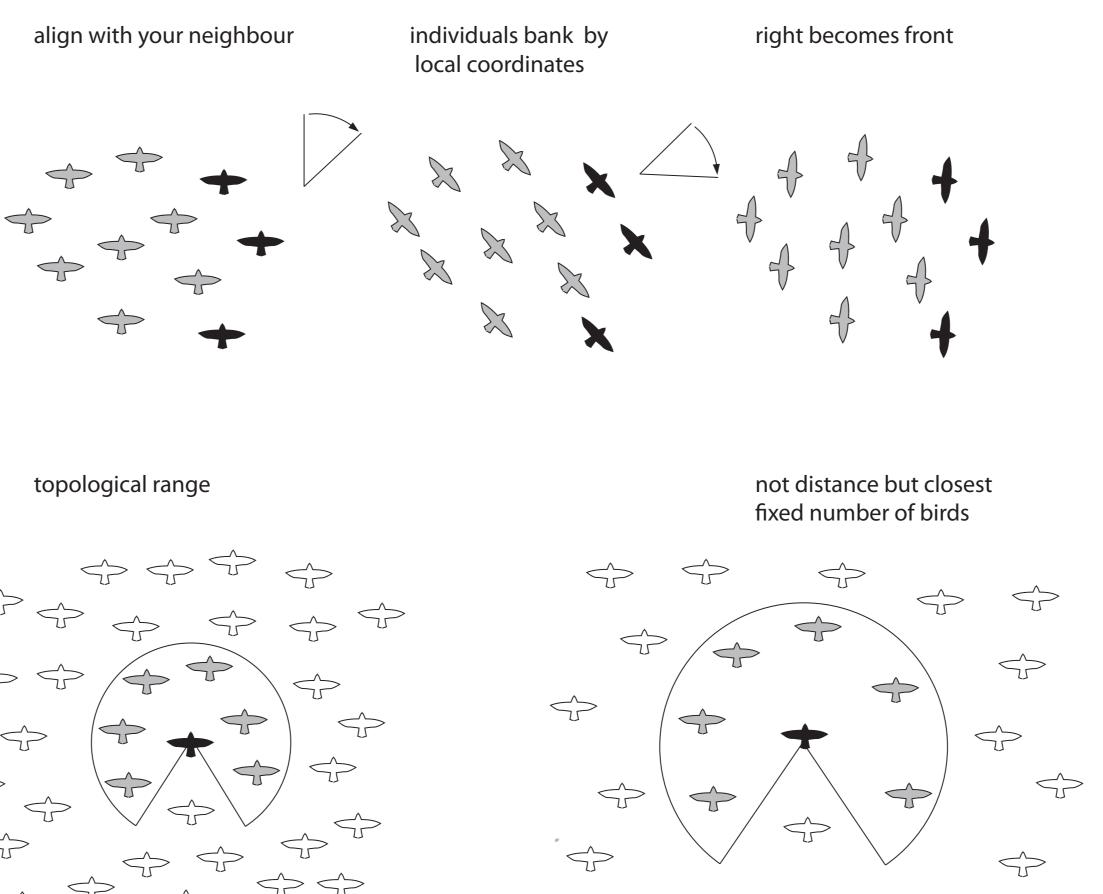
Figure 2 The Great Flight Diagram. The scale for cruising speed (horizontal axis) is based on equation 2. The vertical line represents 10 meters per second (22 miles per hour).

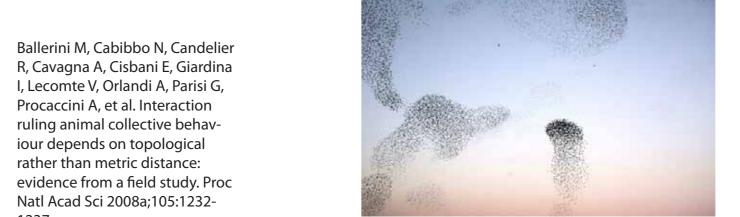


→ wing span: 40 cm
—





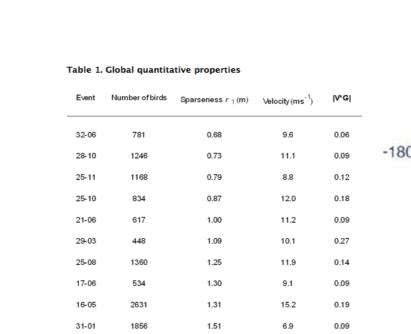




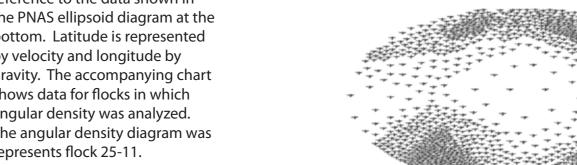
reference to the data shown in the PNAS ellipsoid diagram at the bottom. Latitude is represented by velocity and longitude by gravity. The accompanying chart shows data for flocks in which angular density was analyzed. The angular density diagram was

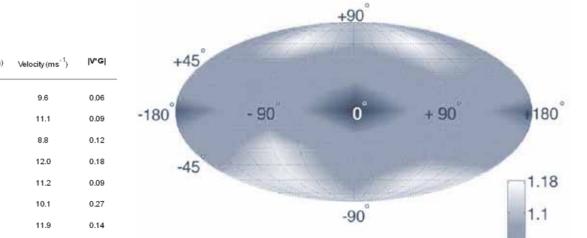
The top diagram was created to

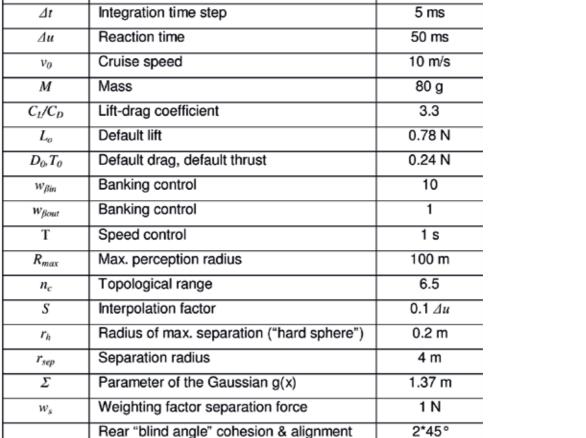
support and provide a physical











Max. perception radius	100 m	
Topological range	6.5	1
Interpolation factor	0.1 <i>∆u</i>	1
Radius of max. separation ("hard sphere")	0.2 m	
Separation radius	4 m	
Parameter of the Gaussian g(x)	1.37 m	-
Weighting factor separation force	1 N	-
Rear "blind angle" cohesion & alignment	2*45°	1
Weighting factor alignment force	0.5 N	-
Weighting factor cohesion force	1 N	-
Critical centrality below which an individual is assumed to be in the interior of a flock.	0.35	
Weighting factor random force	0.01 N	
Boundary radius	150 m	-
Weighting factor horizontal boundary force	0.01 N/m	-
Weighting factor vertical boundary force	0.2 N	-

Table 1. Default parameter values.

H. Hildenbrandt, C. Carere, C-K. Hemelrijk - 'Self-organised complex aerial displays of thousands of starlings: a model' - (year unknown, but later than 2007)

riginal Research Article: Animal Behaviour, Volume 76, Issue 1, July 2008, Pages 201-215 Michele Ballerini, Nicola Cabibbo, Raphael Candelier, Andrea Cavagna, Evaristo Cisbani, Irene Giardina, Alberto Orlandi, Giorgio Parisi, Andrea Procaccini, Massimiliano Viale and Vladimir Zdravkovic

