

# Verbale del Consiglio di Istituto dell'Istituto dei Sistemi Complessi (ISC) del 12 giugno 2017

Il giorno 12 del mese di giugno 2017, presso la sede di Via dei Taurini 19, si è tenuta la riunione del Consiglio di Istituto (Cdi) dell'Istituto dei Sistemi Complessi, con il seguente ordine del giorno

- 1) Situazione Sedi
- 2) Informativa del Direttore in merito alla richiesta del Dr. Cavagna per un supporto straordinario al laboratorio COBBS
- 3) Congresso ISC 2017
- 4) Varie ed eventuali

La riunione ha inizio alle ore 11.15 sono presenti

Prof. Claudio Conti	Presidente
Fabio Cecconi	Componente
Roberta Angelini	Componente
Francesca Colaioni	Componente
Francesco Grazi	Componente, presente tramite collegamento telematico
Stefano Lepri	Componente, presente tramite collegamento telematico
Bruno Tiribilli	Componente, presente tramite collegamento telematico
Giuseppe Faraglia	Componente
Luca Pitolli	Componente
Rosanna Larciprete	Componente assente giustificata

Svolge le funzioni di segretario della riunione il Dr. Fabio Cecconi.

## Punto 1: Situazione Sedi

Il Direttore informa il Cdi che le sedi secondarie di Tor Vergata e Monterotondo hanno cominciato la fase di trasferimento a ISM, mentre la dr.ssa Valentina Mussi ha optato per l'IMM. Probabilmente, entro la fine di luglio dalla Sede Centrale dovrebbero partire i provvedimenti di trasferimento del personale interessato.

Il Direttore comunica al Cdi che il gruppo di neutronica di Firenze chiede il trasferimento in IFAC, il personale TI interessato è il seguente : dr. Colognesi, dr.ssa Celli, dr. Bafile, dr. Grazi e dr. Ulivi. Il dr. Grazi informa che le domande di trasferimento sono in preparazione.

Punto 2: Informativa del Direttore in merito alla richiesta del Dr. Cavagna per un supporto straordinario al laboratorio COBBS

Il dr. Cecconi riassume il documento presentato dal dr. Cavagna (v. All. 1) in cui viene illustrata l'attività e l'eccellenza del Laboratorio COBBS e la situazione critica del medesimo venutasi a creare in seguito al blocco di un finanziamento di 150.000 USD che il Laboratorio avrebbe dovuto ricevere da "Engineer Research and Development Center" della US-Army. Il dr. Cecconi legge le richieste del dr. Cavagna:

- a) Temporanea sospensione del prelievo degli overheads sui Progetti del COBBS ancora attivi in modo da poter utilizzare queste risorse per i rinnovi TD del dr. M. Viale e della dr.ssa S. Melillo per tre mesi ciascuno. Il dr. Cavagna si impegna a restituire le quote dovute a ISC quando il suo Laboratorio avrà ottenuto nuovi finanziamenti;
- b) Richiesta che il successivo rinnovo di sei mesi dei suddetti TD venga finanziato dal conto terzi TD-CNR della Sede Centrale allo scopo di far rientrare il personale TD in questione nel processo di stabilizzazione previsto dall' art. 20 comma 1 e comma 2 del Decreto Legislativo Madia.

Il Cdl accoglie ad unanimità le richieste.

Il Direttore comunica che ha provveduto a inoltrare la richiesta per il conto-terzi agli uffici preposti.

Punto 3: Congresso ISC 2017

Il Direttore informa che il Convegno ISC si terrà il 16 e il 17 ottobre 2017 presso l'Aula Convegni del CNR e chiede notizie sullo stato dell'organizzazione ai membri del Consiglio coinvolti. La dr.ssa Angelini comunica che il programma dell'evento è in fase di stesura e che il Congresso prevedrà la partecipazione di alcuni invited speakers esterni per dare visibilità all'Istituto e promuoverne le collaborazioni.

Punto 4: varie ed eventuali (Associature con incarico di collaborazione)

Il Direttore vuole promuovere l'organizzazione di due meeting tematici sui seguenti argomenti:

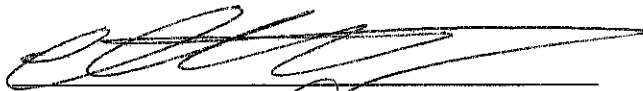
- 1) Carta antica da tenersi presumibilmente a Lucca verso ottobre;
- 2) Topological physics con data da destinarsi.

Il Cdl prende visione delle domande di associatura con incarico di collaborazione pervenute ed esprime parere favorevole (All. 1).

Il Dr. Grazi esprime la volontà di dimettersi in vista del suo trasferimento ad altro Istituto. Il Consiglio approva.

Non essendoci ulteriori punti all'odg, la riunione termina alle ore 12.30.

Claudio Conti



Fabio Cecconi



Roberta Angelini

\_\_\_\_\_ si veda mail allegata \_\_\_\_\_

Francesca Colaioni

\_\_\_\_\_ si veda mail allegata \_\_\_\_\_

Francesco Grazzi

\_\_\_\_\_ si veda mail allegata \_\_\_\_\_


Stefano Lepri

\_\_\_\_\_ si veda mail allegata \_\_\_\_\_

Bruno Tiribilli

\_\_\_\_\_ si veda mail allegata \_\_\_\_\_

Giuseppe Faraglia



Luca Pitolli

\_\_\_\_\_ si veda mail allegata \_\_\_\_\_

## Elisabetta Vuzza

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**Da:** Roberta Angelini <roberta.angelini@roma1.infn.it>  
**Inviato:** mercoledì 14 giugno 2017 18:12  
**A:** Elisabetta Vuzza  
**Cc:** consiglioistituto@isc.cnr.it  
**Oggetto:** Re: verbale Cdl 12/06/2017

Cara Elisabetta,

ho letto ed approvo il verbale del Consiglio d'Istituto ISC del 12 Giugno 2017.

Cari saluti,  
Roberta

## Elisabetta Vuzza

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**Da:** francesco.grazzi@fi.isc.cnr.it  
**Inviato:** lunedì 19 giugno 2017 16:22  
**A:** Elisabetta Vuzza  
**Oggetto:** Re: approvazione verbale Cdl

Sì certo. Scusa. Approvo il verbale nell'ultima versione inviata. Un caro saluto.  
Francesco

## Elisabetta Vuzza

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**Da:** Francesca Colaïori <francesca.colaiori@roma1.infn.it>  
**Inviato:** mercoledì 14 giugno 2017 13:36  
**A:** Elisabetta Vuzza  
**Cc:** consiglioistituto@isc.cnr.it  
**Oggetto:** Re: verbale Cdl 12/06/2017

Grazie Elisabetta,  
per me va bene  
francesca

On 2017-06-14 12:17, Elisabetta Vuzza wrote:

- > Cari tutti,
- >
- > in allegato la bozza del verbale dell'ultimo Cdl per eventuali
- > modifiche e/o integrazioni.
- > Con i migliori saluti
- >
- > Elisabetta
- >
- > Elisabetta Vuzza
- > Responsabile della Segreteria di Direzione Istituto dei Sistemi

## Elisabetta Vuzza

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**Da:** Luca Pitolli <luca.pitolli@isc.cnr.it>  
**Inviato:** giovedì 15 giugno 2017 10:31  
**A:** Claudio Conti - Direttore dell'Istituto dei Sistemi Complessi del CNR; Elisabetta Vuzza; Consiglioistituto  
**Oggetto:** Re: verbale Cdl 12/06/2017

Va bene anche per me.

## Elisabetta Vuzza

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**Da:** bruno.tiribilli@gmail.com per conto di Bruno Tiribilli <bruno.tiribilli@isc.cnr.it>  
**Inviato:** giovedì 15 giugno 2017 11:44  
**A:** fabio ceconi  
**Cc:** Luca Pitolli; Claudio Conti - Direttore dell'Istituto dei Sistemi Complessi del CNR; Elisabetta Vuzza; Consiglioistituto  
**Oggetto:** Re: verbale Cdl 12/06/2017

Ho letto ed approvo il verbale della riunione del 12 giugno 2017 del Cdl ISC.

## Elisabetta Vuzza

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**Da:** Stefano Lepri <stefano.lepri@isc.cnr.it>  
**Inviato:** giovedì 15 giugno 2017 12:48  
**A:** Claudio Conti - Direttore dell'Istituto dei Sistemi Complessi del CNR  
**Cc:** Elisabetta Vuzza; Consiglioistituto  
**Oggetto:** Re: verbale Cdl 12/06/2017

Cari tutti,

approvo il verbale inviato con l'integrazione proposta riguardante le dimissioni di Grazzi. ...

Saluti,

Stefano Lepri Ph.D.  
Consiglio Nazionale delle Ricerche  
Istituto dei Sistemi Complessi  
Via Madonna del Piano, 10 50019 Sesto Fiorentino, Italy Tel. +39 055 5226620 Fax: +39 055 5226683 Skype:  
stefano.lepri  
URL: <http://www.fi.isc.cnr.it/users/stefano.lepri>



Dr Andrea Cavagna  
Primo ricercatore  
Responsabile del Laboratorio COBBS  
Istituto Sistemi Complessi (ISC)  
Consiglio Nazionale delle Ricerche (CNR)

Roma, 12/04/2017

Al Direttore di ISC, Professor Claudio Conti  
e per conoscenza  
al Consiglio di Istituto ISC

Caro Direttore,

Il laboratorio COBBS (Collective Behaviour in Biological Systems) si occupa di ricerca sia sperimentale che teorica nel campo della fisica statistica dei sistemi biologici fortemente correlati. Oltre agli aspetti di ricerca fondamentale, il mio laboratorio ha generato linee applicative in computer vision, come testimoniato dal recente grant applicativo-industriale EC-POC "Proceeds".

A causa di una circostanza eccezionale e difficilmente preventivabile sotto descritta, il mio laboratorio si trova in una situazione finanziaria critica che ne mette a repentaglio la sopravvivenza. Mi vedo dunque costretto a chiedere un supporto sia all'Istituto, che allo stesso CNR.

Ho sempre ritenuto giusto che un gruppo di ricerca si sostenga principalmente tramite i finanziamenti esterni che riesce a reperire. Dunque, data l'eccezionalità e l'anomalia di questa mia richiesta di supporto interno, è mio dovere documentare tre condizioni che ritengo necessarie affinché una tale richiesta venga considerata, ovvero: 1) la comprovata eccellenza scientifica e finanziaria del mio laboratorio; 2) la oggettiva straordinarietà e urgenza della situazione venutasi a creare; 3) la effettiva necessità della richiesta avanzata in relazione al personale precario.

## 1. Eccellenza del laboratorio richiedente e del suo coordinatore

### 1a. Parte scientifica (fonte Scholar)

I miei lavori hanno complessivamente **5400 citazioni e h-index 35**; il mio articolo più importante ha oltre 1000 citazioni. Ho conseguito l'Abilitazione Scientifica Nazionale di Professore Ordinario (prima fascia), sia in Fisica Teorica (FIS/02), che in Materia Condensata (FIS/03). Da quando il laboratorio COBBS e' stato fondato circa 10 anni fa, gli articoli prodotti dal laboratorio hanno raccolto oltre **2500 citazioni**. Fra questi articoli segnalo (in ordine di Impact Factor - IF):

- 1 articolo su *Physics Reports* (IF=22)
- 3 articoli su *Nature Physics* (IF=19), fra i quali un *Cover Article* nel 2014
- 1 articolo su *Annual Review in Condensed Matter* (IF=12)
- 4 articoli su *PNAS* (IF=9)
- 4 articoli su *Physical Review Letters* (IF=8), fra cui 2 selezionati come *Editor Choice* e 1 selezionate per un *Viewpoint* sulla rivista *Physics* dell'American Physical Society

Il contributo del gruppo COBBS alla VQR 2011-2014 dell'Istituto Sistemi Complessi comprende 6 articoli su 6 di classe A.

### 1b. Parte finanziaria

Dalla sua costituzione il laboratorio COBBS (coordinato da me e da Irene Giardina) ha raccolto un totale di **2.441.239 EUR** di grant *interamente versati all'Istituto Sistemi Complessi*; tali grant hanno generato un totale di **133.062 EUR di overhead per l'Istituto** (la percentuale di prelievo overhead e' variata dal 5% al 10% nel corso degli anni). I grant sono stati i seguenti:

- 2010-2013: **605.000 EUR** dall'Istituto Italiano di Tecnologia (progetto ARTWARM)
- 2010-2012: **166.239 EUR** dalla EC, per un IEF Marie Curie (progetto PASSAROLA)
- 2010-2014: **326.000 EUR** dall'Air Force Office of Scientific Research, USA (progetto PANES)
- 2010-2015: **1.124.000 EUR** dall'ERC EU-FP7 (progetto SWARM)
- 2016-2017: **150.000 EUR** dall'ERC-PoC EU-H2020 (progetto PROCEEDS)
- 2016-oggi: **70.000 EUR** EC-Eranet-Lac (progetto CRIB)

Oltre ai grant vinti, il laboratorio COBBS ha costantemente presentato grant proposal; solo nell'ultimo anno COBBS ha sottomesso proposal alle seguenti agenzie: HFSP, Google, Simons Foundation, STM-CNR, PRIN e FIRB. Attualmente COBBS sta aspettando risposte da 2 proposal per il bando di Lazio Innova, 1 proposal all'Agenzia Spaziale Italiana, 1 proposal all'Agenzia Spaziale Europea. Da notare, infine, che grazie alla collaborazione con Irene Giardina (Sapienza) i locali del laboratorio COBBS all'interno del Dipartimento di Fisica di Sapienza non gravano finanziariamente sul nostro Istituto. Infine, e' importante notare che il laboratorio COBBS non beneficia di alcun altro finanziamento extra-ISC, in particolare non e' supportato da alcun grant Sapienza.



## **2. Straordinarietà e urgenza della situazione di fatto**

La situazione finanziaria del laboratorio COBBS e' attualmente critica a causa di un finanziamento di **150.000USD** che il laboratorio doveva ricevere dalla US-Army ERDC (Engineer Research and Development Center) tramite la Portland State University (PSU), ma che, nonostante tutti i passi formali compiuti, non è andato a buon fine. Questi fondi sono parte di un grant approvato ed assegnato al Dr Andrew Goodwin (PI del progetto e membro della US Army ERDC) in collaborazione con me e con la Dr.ssa Stefania Melillo (responsabile sperimentale del laboratorio COBBS); nel grant approvato sono stati messi a budget 150.000USD destinati a ISC-CNR per finanziare la parte sperimentale del progetto svolta dal laboratorio COBBS (v. allegato 1 e seguenti per l'esatta cronologia dei fatti).

Dai primi di febbraio 2017, ovvero da quando il mio laboratorio ha presentato domanda formale della prima tranche del finanziamento, non ho più ricevuto alcuna comunicazione ufficiale da ERDC. Notizie di stampa riguardanti la politica di finanziamento delle agenzie governative da parte della nuova amministrazione americana e il limbo della budget law al Congresso degli Stati Uniti ci rendono pessimisti sul significato di questo prolungato silenzio da parte del nostro partner americano. E' probabile che il budget del progetto ERDC del Dr Goodwin sia stato fortemente ridimensionato e che in questo nuovo contesto il sub-contract ISC sia diventato problematico.

E' importante notare che, anche nella eventualità che la situazione del grant US-ERDC si sblocchi in un prossimo futuro, non ci sarebbe ormai il tempo materiale per trasferire le eventuali risorse da PSU a ISC in tempo utile per gli ormai imminenti rinnovi dei ricercatori a tempo determinato di COBBS.

Voglio sottolineare comunque che il mio laboratorio *non ha speso, ne' impegnato, ne' accertato alcuna parte del finanziamento US-ERDC in questione.*

### 3. Situazione del personale precario del laboratorio richiedente

Attualmente il personale precario del laboratorio COBBS e' il seguente:

- **Dr. Massimiliano Viale (TD): h-index 12 e citazioni totali 2354.** Viale ha un contratto TD con ISC-CNR dal 2011 con **scadenza giugno 2017**. Viale ha dunque i requisiti indicati nell'art. 20 *comma 1* del Decreto Legislativo Madia (in servizio con contratto a tempo determinato, selezionato con procedure concorsuali con più di 3 anni di servizio). Viale e' il membro ISC più senior di COBBS dopo il sottoscritto; ha una vasta esperienza sia analitica che numerica in fisica statistica ed è parte essenziale sia delle linee di ricerca teoriche del nostro gruppo, sia di quelle di computer vision.
- **Dr.ssa Stefania Melillo (TD): h-index 7 e citazioni totali 262.** Melillo ha lavorato nel laboratorio dal 2010 al 2015 come assegnista di ricerca e da dicembre 2015 ad oggi con un contratto TD con **scadenza a maggio 2017**. Melillo ha i requisiti indicati nell'art. 20 *comma 2* del Decreto Legislativo Madia (in servizio con contratto di lavoro flessibile con più di 3 anni di servizio). Melillo e' la responsabile sperimentale di COBBS e di tutta la strumentazione del laboratorio, ed e' la coordinatrice di tutte le campagne sperimentali di presa dati sul campo; Melillo contribuisce inoltre in modo decisivo alla linea di ricerca applicativa di computer vision.
- **Dr. Leonardo Parisi (Ass.Ric.): h-index 9 e citazioni totali 306.** Parisi e' assegnista di ricerca con contratto in scadenza ad agosto 2017. Parisi ha svolto sia la sua tesi di Master sia il suo PhD In Computer Science nel laboratorio COBBS e fornisce un contributo determinante alla linea di ricerca in computer vision.
- **Dr.ssa Agnese D'Orazio (Ass.Ric.):** assegnista di ricerca dal 2010, svolge mansioni di supporto alla attività di ricerca del laboratorio COBBS. D'Orazio e' al momento in maternità fino ad agosto 2017. Il contratto di D'Orazio scade a novembre 2017.

Il finanziamento US-ERDC descritto alla pagina precedente doveva dare stabilità finanziaria al laboratorio COBBS fino all'anno 2019, permettendo la stabilizzazione di Viale ed eventualmente di Melillo, nonché il rinnovo di D'Orazio alla fine del periodo di maternità, in attesa di una sua partecipazione a concorsi di arruolamento non precario. Inoltre, in questo scenario il laboratorio avrebbe avuto il tempo di sottomettere altri proposal di finanziamento. Invece, a causa dell'imprevisto stallo del grant US-ERDC descritta sopra, lo scenario finanziario programmato dal laboratorio COBBS non è più praticabile; il mio laboratorio si trova in una situazione finanziaria insostenibile che rischia di portare velocemente ad un collasso delle capacità di ricerca del laboratorio stesso.

## Richiesta

A seguito della situazione creatasi per il mio laboratorio, ho deciso di presentare con questa mia lettera una richiesta di supporto straordinario sia da parte di ISC, sia da parte del CNR, al fine di garantire la sopravvivenza del mio laboratorio. Nello specifico:

1. richiedo a ISC che il prelievo della quota di overhead dal grant POC-Proceed sia sospeso, in modo da poter utilizzare queste risorse per il prossimo imminente rinnovo TD del Dr Viale (scadenza 06/2017) e della Dr.ssa Melillo (scadenza 05/2017). Mi impegno a restituire queste risorse ad ISC una volta che il mio gruppo avrà ricevuto futuri nuovi finanziamenti. Se questa sospensione del prelievo overhead verrà accordata, potrò garantire i rinnovi dei due ricercatori TD per 3 mesi ciascuno e al contempo garantire le spese minime di funzionamento del mio laboratorio; tuttavia, non potrò coprire i successivi rinnovi TD di settembre e ottobre 2017, né il rinnovo degli assegnisti, motivo per il quale:
2. tenuto conto del valore scientifico di Viale e Melillo, della loro anzianità di servizio e della importanza del loro ruolo per la vita del mio laboratorio, richiedo che il successivo rinnovo di 6 mesi di Viale (10/2017) e il successivo rinnovo di 6 mesi di Melillo (09/2017) venga effettuato sul conto terzi TD-CNR. Questa azione garantirebbe la sopravvivenza del mio laboratorio fino al prossimo finanziamento esterno e permetterebbe al Dr Viale ed alla Dr.ssa Melillo di usufruire delle eventuali stabilizzazioni relative al Decreto Madia (comma 1 per Viale e comma 2 per Melillo).

In conclusione, sono perfettamente consapevole del fatto che le risorse del conto terzi TD-CNR sono limitate e che dunque la richiesta di accesso da parte di personale ISC a queste risorse deve considerarsi del tutto eccezionale e supportata da forti considerazioni scientifiche. Sono altresì consapevole del fatto che il mio laboratorio ha un valore scientifico e un impatto finanziario di notevole rilievo, e che i ricercatori TD per i quali chiedo queste risorse hanno un comprovato track record scientifico e bibliometrico che può sicuramente competere con successo con altre analoghe richieste. Auspico dunque che ogni richiesta ed esigenza simile a quella del mio laboratorio venga valutata sulla base di criteri oggettivi di natura esclusivamente scientifica.

Ti saluto e ti ringrazio per l'attenzione,



Dr Andrea Cavagna  
Laboratorio COBBS  
Istituto Sistemi Complessi  
Consiglio Nazionale delle Ricerche

## **Allegato 1**

Riassunto cronologico US-ERDC:

- *novembre 2015*: vengo contattato dal Dr Goodwin per un progetto sul comportamento collettivo degli stormi di rondoni (allegato 2); accetto di partecipare con la Dr.ssa Melillo (responsabile sperimentale di COBBS) alla stesura di un grant proposal congiunto da sottomettere a ERDC;
- *febbraio 2016*: il proposal viene sottomesso a ERDC (estratto in allegato 3); sia io che Melillo siamo PI del proposal ed e' messo a budget un finanziamento per ISC di 150.000USD;
- *luglio 2016*: il progetto viene approvato da ERDC; dai report dei reviewer (allegato 4) si evince che l'approvazione del grant e' stata determinata in modo decisivo dall'eccellenza del laboratorio COBBS;
- *settembre 2016*: la Dr.ssa Melillo trascorre un periodo di 3 settimane a Portland per raccogliere dati pilota sul progetto in collaborazione con Goodwin e Siderius;
- *novembre 2016*: come previsto dal progetto, ISC e PSU vengono invitati da ERDC a sottomettere una lettera congiunta di interesse per partecipare al progetto come sub-contractor, cosa che viene fatta (allegato 5);
- *febbraio 2017*: ISC e PSU vengono formalmente invitati a sottomettere il full proposal per il finanziamento della tranche 2017 di 59.000USD (allegato 6), cosa che viene fatta (allegato 7).



Andrea Cavagna <andrea.cavagna@gmail.com>

Allegato 2

## Advice for measuring detailed, 4-D positions of a moving bird flock

R. Andrew Goodwin <r.andrew.goodwin@gmail.com>

To: andrea.cavagna@gmail.com, andrea.cavagna@roma1.infn.it

Cc: "Dr. Richard A. Fischer" <Richard.A.Fischer@erdc.dren.mil>

8 November 2015 at 18:35

Hi Andrea,

I'm a research engineer with the Environmental Laboratory, U.S. Army Engineer R&D Center where I focus on understanding and forecasting animal movement behavior near infrastructure. Here are some papers for reference:

PNAS: [www.pnas.org/content/111/14/5277](http://www.pnas.org/content/111/14/5277)

Proc of Royal Society, B: <http://rspb.royalsocietypublishing.org/content/280/1754/20122003>

J. Theoretical Biology: [www.sciencedirect.com/science/article/pii/S0022519309003658](http://www.sciencedirect.com/science/article/pii/S0022519309003658)

PLoS One: <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0136057>

Most of my work has focused on fish in 3-D, but presently we're designing a study to analyze the dynamics that underlie 4-D movement of these Vaux's swifts as they flock above and into a chimney under predation (hawks/falcons) near where I live in Portland, Oregon USA:

[www.youtube.com/watch?v=uthNqso6VEIE](http://www.youtube.com/watch?v=uthNqso6VEIE)

I would like to measure each individual swift within the flock (and each hawk/falcon) with the highest 4-D (3-D, time) resolution possible as part of the analysis, both as the individual swifts flock above the chimney but also as the swifts enter into and set up positions within the chimney.

I have admired your work for years, and was wondering if there is a way for us to build off your work? Do you have any advice that you could share, such as what's feasible and emerging in the state-of-the-art, instrumentation, and software?

I would be happy to chat over the phone, if you are willing.

Thanks, Andy

**BASIC RESEARCH PROPOSAL COVER PAGE**

<b>1. SUBMIT TO:</b>  Director U.S. Army Engineer Research and Development Center	<b>2. For consideration by:</b> <input checked="" type="checkbox"/> Environmental Quality Installations <input checked="" type="checkbox"/> Geospatial Research and Engineering <input checked="" type="checkbox"/> Military Engineering <input checked="" type="checkbox"/> Other/Cross Business Areas	<b>3. ERDC experience</b>  <input type="checkbox"/> Less than 5 years <input checked="" type="checkbox"/> 5 to 15 years <input checked="" type="checkbox"/> More than 15 years
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**4. Title of Proposed Project:**  
 Structure and resilience of unbounded 100+km/h. time-varying 3-D. multi-phased active matter

**5. Table of Contents.**

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<b>6. Total Proposed Amount</b> \$1.393K	<b>7. Proposed Duration (# of months)</b> 36 months	<b>8. Proposed Start Date:</b> 1 Oct 2016
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**9. Principal Investigator (PI) telephone numbers and email address.**

R. Andrew Goodwin, PhD  
 (503) 382-7194  
 Andy.Goodwin@usace.army.mil

TYPED NAMES	OFFICE TELEPHONE NUMBER	CELL/ BLACKBERRY NUMBER	E-MAIL ADDRESS
Richard A Fischer, PhD	(502) 454-4658	(502) 641-7824	Richard.A.Fischer@usace.army.mil
Andrea Cavagna, PhD (Intended)	+39 06 4993 7460		Andrea.Cavagna@roma1.infn.it
Stefania Melillo, PhD (Intended)	+39 06 4993 7460		Stefania.Melillo79@gmail.com

**Director of Submitting Laboratory** - In signing this block, I am certifying I have reviewed this proposal and find it is representative of Basic (6.1) level research.

*R. A. Fischer*  
 Director, Submitting Laboratory

## CURRICULUM VITAE – Intended co-PI

- a. **Title:** Structure and resilience of unbounded 100+km/h, time-varying 3-D, multi-phased active matter.
- b. **Name:** Andrea Cavagna, Ph.D.
- c. **Current Position, Department and Division:** Faculty Researcher at the Institute for Complex Systems – CNR, Italy
- d. **Education:**
  - 1998 Ph.D. (Theoretical Physics), University of Rome Sapienza, Italy.
  - 1994 M.Sc. (Physics), University of Milan, Italy.
- e. **Relevant Professional Experience or Employment:**
  - 2001-Present: Researcher at the Institute for Complex Systems – CNR, Italy.
  - 1999-2001: Postdoc in the Theoretical Physics group of Alan Bray and Mike Moore, Department of Physics and Astronomy, University of Manchester.
  - 1998-1999: Postdoc in the Condensed Matter Physics group of David Sherrington, Department of Theoretical Physics, University of Oxford.
- f. **Relevant Publications:**
  - A. Cavagna, C. Creato, L. Del Castello, I. Giardina, S. Melillo, L. Parisi, M. Viale, Error control in the set-up of stereo camera systems for 3d animal tracking, *The European Physical Journal Special Topics*, 224(17-18), 2015, 3211-3232.
  - A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, A. Jelić, S. Melillo, L. Parisi, F. Pellacini, E. Shen, E. Silvestri, M. Viale, GReTA – A novel global and recursive tracking algorithm in three dimensions, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 37(12), 2015, 2451-2463.
  - A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, T.S. Grigera, A. Jelić, S. Melillo, L. Parisi, O. Pohl, E. Shen, M. Viale, Information transfer and behavioural inertia in starling flocks, *Nature Physics*, 10(9), 2014, 691-696.
  - A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, S. Melillo, L. Parisi, O. Pohl, B. Rossaro, E. Shen, E. Silvestri, M. Viale, Finite-size scaling as a way to probe near-criticality in natural swarms, *Phys. Rev. Lett.*, 113(23), 2014, 238102.
  - W. Bialek, A. Cavagna, I. Giardina, T. Mora, E. Silvestri, M. Viale, A. M. Walczak, Statistical mechanics for natural flocks of birds, *Proc. Natl. Acad. Sci. USA*, 109(13), 2012, 4786-4791.
  - A. Cavagna, A. Cimorelli, I. Giardina, G. Parisi, R. Santagati, F. Stefanini, M. Viale, Scale-free correlations in starling flocks, *Proc. Natl. Acad. Sci. USA*, 107, 2010, 11865.
  - M. Ballerini, N. Cabibbo, R. Candelier, A. Cavagna, E. Cisbani, I. Giardina, V. Lecomte, A. Orlandi, G. Parisi, A. Procaccini, M. Viale, V. Zdravkovic, Interaction ruling animal collective behaviour depends on topological rather than metric distance: Evidence from a field study, *Proc. Natl. Acad. Sci. USA*, 105, 2008, 1232.





Publications Impact (Scholar): **h-index 31**; total citations: **4571**; top three most cited papers:

- *Proc. Natl. Acad. Sci. USA*, 105, (2008) – times cited **823**
- *Physics Reports*, 51, (2009) – times cited **323**
- *Proc. Natl. Acad. Sci. USA*, 107, (2010) – times cited **314**

**g. Invention Disclosures and Patent Applications:**

**h. Research Achievement and Recognition Awards:**

- 2014 - National Scientific Qualification for Full Professor in Theoretical Physics of Fundamental Interactions and Condensed Matter Physics.
- 2010-2015 - co-PI of **SWARM**, a project funded by the ERC, for the study of collective behaviour in birds and swarms (**1.1M EUR** - PI: Irene Giardina).
- 2010-2014 - local PI of **PANES** (Principles and Algorithms for Natural and Engineered Swarms), a project funded by the Air Force Office of Scientific Research-US for the study of collective behaviour (FA95501010250) (**400K USD**).
- 2010-2013 - co-PI of **ART-SWARM**, a project funded by the Italian Institute of Technology, for the study of collective behaviour in insect swarms (**600K EUR** - PI: Irene Giardina).
- 2005-2007 - PI of the INFM node of the EC project **STARFLAG**: Starling in flight: understanding the patterns of animal movement (**320K EUR** - European Coordinator: Giorgio Parisi).
- 2004 - Qualification for the functions of University Professor in France in sector: "28-Milieux Denses et Materiaux" and in sector: "29-Constituants Elementaires"

**i. Previous Research Results:**

- None for the ERDC 6.x or other ERDC programs.
- 2008 - I setup the first 3-D acquisition apparatus for the experimental study of large flocks of birds in the field; I developed the tracking algorithm to study this system; I discovered from the data that the interaction in large flocks of birds is based on topological distance rather than metric distance.
- 2010 - I discovered through experiments and theoretical analysis that correlation functions in bird flocks are scale-free, an indication that these systems are close to a critical point.
- 2014 - I run a new campaign of data acquisition on insect swarms, discovering that these systems too are close to a critical point, in that they have unusually large correlations.
- 2014 - I discovered through experiments that the law of information propagation across bird flocks is linear and I have developed a new theory for this that has been verified experimentally.

**j. Alphabetized List of Collaborators: (Past 48-months)**

- **W. Bialek** (Princeton Univ), **I. Giardina** (Univ of Rome Sapienza, Italy), **TS. Grigera** (Univ La Plata, Argentina), **P. Krishnaprasad** (Univ. Maryland), **D. Levine** (Technion, Israel), **T. Mora** (ENS, Paris), **S. Ramaswamy** (TIFR, India), **A. Walczak** (ENS, Paris).

## CURRICULUM VITAE – Intended co-PI

- a. **Title:** Structure and resilience of unbounded 100+km/h, time-varying 3-D, multi-phased active matter.
- b. **Name:** Stefania Melillo, Ph.D.
- c. **Current Position, Department and Division:** Researcher at the Institute for Complex Systems – CNR, Italy
- d. **Education:**
  - 2010 Ph.D. (Mathematics), University of Roma Sapienza, Italy.
  - 2006 Master Degree (Mathematics), University of Roma Sapienza, Italy.
- e. **Relevant Professional Experience or Employment:**
  - 2012-Present: Senior Postdoctoral Researcher, CoBBS Lab (Collective Behaviour in Biological Systems Laboratory), Institute for Complex Systems – CNR, Italy.
- f. **Relevant Publications:**
  - A. Cavagna, C. Creato, L. Del Castello, I. Giardina, S. Melillo, L. Parisi, M. Viale, Error control in the set-up of stereo camera systems for 3d animal tracking, *The European Physical Journal Special Topics*, 224(17-18), 2015, 3211-3232.
  - A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, A. Jelić, S. Melillo, L. Parisi, F. Pellacini, E. Shen, E. Silvestri, M. Viale, GR<sub>e</sub>TA – A novel global and recursive tracking algorithm in three dimensions, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 37(12), 2015, 2451-2463.
  - A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, T.S. Grigera, A. Jelić, S. Melillo, L. Parisi, O. Pohl, E. Shen, M. Viale, Information transfer and behavioural inertia in starling flocks, *Nature Physics*, 10(9), 2014, 691-696.
  - A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, A. Jelić, S. Melillo, L. Parisi, O. Pohl, E. Shen, M. Viale, Emergence of collective changes in travel direction of starling flocks from individual birds' fluctuations, *J. of The Royal Society Interface*, 12(108), 2015.
  - A. Cavagna, L. Del Castello, S. Dey, I. Giardina, S. Melillo, L. Parisi, M. Viale, Short-range interaction vs long-range correlation in bird flocks, *Phys. Rev. E*, 92, 2015, 012705.
  - A. Cavagna, I. Giardina, T.S. Grigera, A. Jelić, D. Levine, S. Ramaswamy, M. Viale, Silent Flocks: Constraints on signal propagation across biological groups, *Phys. Rev. Lett.*, 114, 2015, 218101.
  - A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, S. Melillo, L. Parisi, O. Pohl, B. Rossaro, E. Shen, E. Silvestri, M. Viale, Finite-size scaling as a way to probe near-criticality in natural swarms, *Phys. Rev. Lett.*, 113(23), 2014, 238102.
  - A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, S. Melillo, L. Parisi, O. Pohl, B. Rossaro, E. Shen, E. Silvestri and others, Collective behaviour without collective order in wild swarms of midges, *PLoS Computational Biology*, 10(7), 2014, e1003697.

**g. Invention Disclosures and Patent Applications:**

**h. Research Achievement and Recognition Awards:**

- Cover paper, *Nature Physics*, 10(9), (2014).
- Physics Viewpoint, *Phys. Rev. Lett.*, 113(23), (2014).

**i. Previous Research Results:**

- None for the ERDC 6.x or other ERDC programs.
- 2010-2015 - Leader of the experimental team at CoBBS Lab (Collective Behaviour in Biological Systems Laboratory), Institute for Complex Systems – CNR, Italy.
- 2010-2015 - Designed the set-up and data acquisition for stereoscopic experiments on midge swarms and bird flocks.
- 2010-2015 - Designed, tested, and implemented C++ software published on TPAMI(2015) to reconstruct the three-dimensional trajectories of animals moving in a group and performing collective motion.
- 2010-2015 - Implemented the C++ software for data analysis on midge swarms published in *Phys. Rev. Lett.*, 113(23), 2014 and *PLoS Computational Biology*, 10(7), 2014.

**j. Alphabetized List of Collaborators: (Past 48-months)**

- **W. Bialek** (Princeton Univ), **I. Giardina** (Univ of Rome Sapienza, Italy), **TS. Grigera** (Univ La Plata, Argentina), **B. Rossaro** (Univ. Milan, Italy), **Z. Wu** (Boston Univ).

# COST ESTIMATE

## Basic Research Project Cost Estimate

Prepared by: R. Andrew Goodwin  
 Preparation/Revision Date: 10 Feb 16 / 10 Feb 16

Proposed Business Area: Cross: EQ/1, GRE, Military Engineering  
 Strategic Research Area: (Austere Entry and Maneuver; Environmental Impacts on Sensor Performance; Other Innovative Research).

Cross: EQ/1, GRE, Military Engineering  
 Cross: EQ/1 (Fundamental Processes in the Environment; Biological Network Science), GRE (Geospatial Intelligence), Military Engineering  
 (Austere Entry and Maneuver; Environmental Impacts on Sensor Performance; Other Innovative Research).

### Title of Proposed Project: Structure and resilience of unbounded 100-km/h, time-varying 3-D, multi-phased active matter

DESCRIPTION	FY17			FY18			FY19			TOTAL		
	TOTAL HOURS	TOTAL COST	LABOR RATE	TOTAL HOURS	TOTAL COST		TOTAL HOURS	TOTAL COST		Total Hours	Total Cost	
DIRECT LABOR CATEGORIES												
PI Dr. R. Andrew Goodwin	480	\$79,200	\$165.00	480	\$81,576		440	\$76,468		1400	\$238,184	
Co-PI Dr. Richard A. Fischer	320	\$55,040	\$172.00	320	\$56,691		280	\$52,013		920	\$163,744	
Co-PI Andrea Cavagna (Intended)	180	\$12,000	\$75.00	120	\$9,000		253	\$19,000		533	\$40,000	
Co-PI Stefania Mellis (Intended)	960	\$40,000	\$41.87	720	\$30,000		960	\$40,000		2640	\$110,000	
Postdoc			\$60.10	782	\$47,000		2080	\$125,000		2862	\$172,000	
CEERD-EEC / Hollis H. (Jay) Bennett, Jr.	300	\$39,375	\$131.25	300	\$40,556		600	\$79,981		600	\$79,981	
Administrative Support (Goodwin)	60	\$4,500	\$75.00	60	\$4,635		60	\$4,860		180	\$13,995	
Administrative Support (Fischer)	60	\$4,500	\$75.00	60	\$4,635		60	\$4,860		180	\$13,995	
TOTAL DIRECT LABOR	2340	\$234,615		2842	\$274,093		4,133	\$324,141		9315	\$632,849	
TRAVEL		\$23,558			\$32,267			\$0			\$55,825	
EQUIPMENT and SUPPLIES (advanced high-speed camera equipment, see next page)		\$145,901			\$4,438			\$0			\$150,338	
OTHER											\$0	
CONTRACT COSTS		\$16,000			\$6,200			\$2,000			\$24,200	
TOTAL DIRECT COSTS		\$185,459			\$42,905			\$2,000			\$230,363	
Laboratory Departmental		\$103,294	43.50%		\$56,073.46			\$80,910.00			\$240,277.91	
G&A		\$38,468	16.20%		\$20,882.53			\$30,132.00			\$89,482.81	
TOTAL COSTS		\$581,856			\$393,954			\$497,183			\$1,397,973	

Allegato 4



stefania melillo &lt;stefania.melillo79@gmail.com&gt;

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**FW: Cross Business Area proposal "Structure and Resilience of Unbounded 100+Km/H, Time-Varying 3-D, Multi-Phased Active Matter"**

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Goodwin, Andy ERDC-EL-MS <Andy.Goodwin@usace.army.mil> 21 maggio 2016 02:12  
A: Andrea Cavagna <andrea.cavagna@roma1.infn.it>, stefania melillo <stefania.melillo79@gmail.com>  
Cc: "Fischer, Richard A ERDC-EL-MS" <Richard.A.Fischer@erdc.dren.mil>

Good news, the Vaux swift proposal attached has been tentatively approved. I have to brief the project 15 June and address reviewers' criticisms (below). I'll start working on developing my notes for the brief shortly.

Andrea/Stefania, would you happen to be around and available to Skype Monday (23 May) or Tuesday?

Andy

-----Original Message-----

From: Rogers, James P II ERD-VA  
Sent: Monday, May 16, 2016 8:03 AM  
To: Goodwin, Andy ERDC-EL-MS  
Subject: Cross Business Area proposal "Structure and Resilience of Unbounded 100+Km/H, Time-Varying 3-D, Multi-Phased Active Matter"

The Cross Business Area Basic Research Evaluation Panel invites you to present your full proposal, "Structure and Resilience of Unbounded 100+Km/H, Time-Varying 3-D, Multi-Phased Active Matter" at the Basic Research Portfolio Management Review 14-16 June, in Vicksburg. Please note that this does NOT guarantee final approval as a funded new start in FY17, but does indicate a high level of quality research. Below are reviewer comments on your proposal. Please provide me the following information by COB 20 May: 1) If you will be presenting at the Management Review in person or remotely 2) A contact phone number so that I may reach you on the day of your brief and inform you if the schedule is not running on time. If you have any further questions, please do not hesitate to contact me.

James P. Rogers, PhD, PE  
ERDC Programs Office, Basic Research  
703-428-9114 office

**Reviewer 10536**

**Technical Merit Comments:** This proposes to track and analyze time-dependent 3-dimensional data for the flocking behavior of Vaux's swift birds, which display fascinating collective behavior. One of the main goals is to extract from the data the interaction rules that the birds use, including how many other birds each individual is influenced by, and how the behaviors are affected by predators. They also want to investigate airborne milling behavior shown by the flock, a rare behavior for bird flocks. The proposers outline a very detailed plan for how they will proceed, and they have strong expertise in the technical experimental challenges that will arise.

**Scientific Impact Comments:** There is much interest in understanding the interaction rules that give rise to different types of collective motion. The proposed research represents a rare opportunity to learn about these rules from real bird flocking data. The team's related research on starlings has been very impactful, and it is likely that the proposed research will be similarly impactful.

**Investigator Qualifications Comments:** The investigators are well qualified. This is a very challenging project, but they have already shown themselves to be capable in their previous work.

Recommend Research Comments: This is very interesting research, and a great team!

Overall Assessment Comments: This is an ambitious proposal, but I believe that the researchers have the right skills and backgrounds to be successful.

**Reviewer 11896**

Technical Merit Comments: The proposed work includes a clear set of hypotheses that will investigate the nature of the interaction schemes in fast-moving flocks and the characteristics of successful predatory captures. The proposal gives a comprehensive survey of related work on the study of collective motion in the physics, applied math, and biology literature, although work on flocking in the field of swarm robotics is not cited as thoroughly. The first objective of the project is to obtain a large, precise 4D data set of different types of flocking motion in various scenarios. The approach to this objective is described thoroughly, in contrast to the approaches for objectives 2-4, which are outlined in less detail although they are the ones that involve testing the proposed hypotheses. Although, as the PIs note, the specific techniques that are ultimately used will depend on the analysis of the measurement data, the lack of detail on possible approaches is a weakness of the proposal.

Scientific Impact Comments: This project would provide insights into the propagation of information and consensus of movement in large, fast-moving groups of agents with complex 3D collective motions. It will also contribute to an understanding of the resilience of collective behaviors in the presence of internal (goal-oriented) and external (attacks) stressors and the propagation of network failures. The first aspect has been studied in flocks of slower-moving starlings (as the PIs note), while the second aspect has the potential to yield entirely new information.

Investigator Qualifications Comments: The project team is uniquely qualified to conduct the proposed research. The PI has prior work on studying the collective motion of self-organizing systems, and one co-PI is a wildlife biologist who will lead the fieldwork component of the project. Two of the co-PIs are experts in the measurement and analysis of collective motion by large bird flocks and have performed similar work on starling murmurations in Italy.

Recommend Research Comments: The proposed work is highly likely to produce novel data on collective motion and yield new insights into the mechanisms underlying different types of collective behaviors, and so I think that if the PIs can elaborate further on their technical approach to objectives 2-4, it should be given high priority for funding. It would also be helpful if they could give a more concrete explanation of how, specifically, the proposed objectives and hypothesis evaluation could potentially contribute to the important application of reducing bird/aircraft strike hazards.

Overall Assessment Comments: The proposal addresses compelling questions about the mechanisms that produce complex collective motions, but should include further details on the technical approach that it will employ.

**Reviewer 11902**

Technical Merit Comments: The investigators have clear research objectives building upon very similar prior work that has helped to shape their thinking about such problems. However, although the researchers show a strong understanding of prior work (done by themselves and other groups) in the analysis of bird flocks and fish schools, I found myself somewhat disappointed by the omission of references to very similar 3D tracking work in insects as well as ecological work addressing the costs and benefits of individual variance in collective motion as well as the speed and maneuverability tradeoffs that occur even in individual predators and prey. For example: \* The Ouellette lab (Stanford, previously at Yale) has recently published several articles a very strong experimental setup for the automated 3D tracking of midges in swarms. Those swarms lack the strong correlated motion of starling and swift flocks, but they have been thought to be generated by the same microscopic movement rules in a qualitatively different region of the parameter space. However, the microscopic statistics of Ouellette and his group show that the conceptual Vicsek-like model of collective motion that seems to dominate the minds of collective-motion researchers may be a good match for macroscopic dynamics but not the best candidate for the microscopic dynamics. For me, this observation is much more interesting than the topological-vs-metric distance debate that was recently invented in the literature (partly by one of the investigators on

this proposal). \* Several years ago, Alta De Vos and M. Justin O'Riain (doi:10.1098/rsbl.2009.0628) performed one of the first empirical tests of the selfish herd hypothesis that drives the intuition that the adaptive benefit of flocks is for the mitigation of individual risk of predation. In that work, dummy seals were positioned in fixed networks floating on the ocean surface, where one "seal" was placed at a slightly larger distance from all other seals, and this individual in the cluster was nearly always targeted by sharks. So topological distance may be important for long-term cohesion, but metric distance (or Voronoi neighbors) do matter at short time scales. Despite this recent example as some of the only real empirical evidence for selfish herding in response to predation, it seems to be ignored by many investigators of collective motion (perhaps because the dummy seals were not moving). But this seems to me to overlap with the second set of hypotheses the investigators here are attempting to test. That is, we do predict that individual "failures" will lead to an increase in predation risk if that individual increases its distance between itself and neighbors. So although there may be some very proximate social-behavioral-protocol failure that causes this (e.g., a broken estimator inside the individual agent's movement control routines), the more descriptive source of the risk is the increase in distance between the individual and those around it. It's just the statistics of risk mitigation when there is one predator and many prey. Furthermore, acknowledging that adaptive benefits come from spacing helps to connect visually appealing collective motion research to more useful collective resource allocation. For example, the classic work by Franks and Sendova-Franks (1992, doi:10.1007/BF00173947, somewhat related to ref. 21) on brood sorting in *Temnothorax* (formerly *Leptothorax*) ants where appropriately sized "domains of care" are created around the most needy brood (i.e., the largest larvae). There are direct connections between domains of care and domains of danger that have the potential of connecting collective motion literature to much more interesting applications, and yet these connections (which have clearer short-term payoffs) are ignored and we're left with more researchers focussing on the longer-term goals that have less obvious utility. \* The authors state that this study is important because it focuses on an animal system, Vaux's swifts, that move at such high velocity that they might have qualitatively different behavioral patterns than the more conventionally studied starlings. They hope to elucidate these differences through analysis of the high-resolution 3D data taken of the flocks, but it seems like there are more fundamental biomechanical considerations. There have been a handful of studies over the past few decades studying speed-accuracy/maneuverability tradeoffs in predator-prey systems (such as Gendron and Staddon (1982)), but the importance of speed's effect on accuracy and maneuverability has long gone without detailed investigation. Recently, researchers have started to fill in this gap. For example, ecological physiologists, like Robbie Wilson (University of Queensland), have started to tackle how there is a complex relationship between the speed and accuracy characteristics of predator and prey, and that helps to explain why predators almost never travel at their top speed. It seems silly to assume that such speed-accuracy considerations will not be important in these swarms. This is certainly known to some of the investigators, as some are engineers who must be familiar with the so-called Dubin's car (optimal unicycle) that captures the salient features of speed-accuracy tradeoffs on fixed-wing flying vehicle design (and groups that have overlapped with some of the investigators in the past have studied collections of Dubin's vehicles from a control-theoretic standpoint). Additionally, there is now some literature (e.g., Lemasson et al., 2016, doi:10.1371/journal.pcbi.1004708) that shows that the coordination among individuals in a swarm of prey actually increases the speed at which a predator can achieve an attack, and so there is a potential cost to coordination. But I see no awareness of the literature on maneuverability/accuracy and speed in the proposal. I just see a lot of 3D data fishing with presumptive titles in proposed deliverables. Beyond those three examples, I'm disappointed at the lack of influence from behavioral ecology. The authors are largely focused at proximate mechanisms, and that's fine, but they seem to have no awareness of the other constraints and drivers of the system. These gregarious birds do not form aggregations which have properties that are "good for the group." These aggregations are purely driven by selection at the individual group level to (we think!) mitigate predation risk. The authors talk about studying how the characteristics of the swifts may promote "resilience under attack," but ultimately the epiphenomenon of these beautiful flocks results in increased survival of individuals in the flock as opposed to some interesting feature (like connectivity of the flock itself). I think the investigators would argue that starlings appear to pay attention to seven of their closest neighbors at a time, and such an organization helps to ensure that there is almost always a single connected component, and that's a desirable feature when building flying robots, but that single connected component is almost surely a proximate mechanism (or an emergent epiphenomenon) and not a property under selection, and so it's probably not a good idea to build engineered systems mimicking the proximate mechanisms of a group of gregarious birds that almost surely have no ultimate "reason" to maintain any useful group-level

properties aside from those that protect individual birds, potentially at the cost to lower performing birds in the heterogeneous flock. If the investigators really do want to "transition [their] findings to design principles for engineered systems", they need to appreciate all four of Tinbergen's questions: speed and maneuverability matters, and the position of selective pressure matters. It's possible to learn a lot from these gregarious birds as applied to engineered systems, but it's not clear what property the investigators are hoping to import into our designs. As mentioned above, they talk about studying how the characteristics of the swifts may promote "resilience under attack," and they are interested in studying "how network failures propagate in time and space." Has anyone ever documented a "network failure" propagating in swifts (or starlings)? What would something like that look like? Are the investigators saying that the failure to find such failures indicates that the swifts are just that good at rejecting those failures? Or is it possible that looking for network failures in swifts is an ill-formed objective? The authors talk about studying how the characteristics of the swifts may promote "resilience under attack," and they are interested in studying "how network failures propagate in time and space." Very minor additional point: The authors focus on milling behavior in biological system but seem to completely ignore army-ant mills. These mills are almost certainly pathological, but they are very easy to produce in the lab and are a clear result of the difficulty of building local rules to enforce (or reject) global behavior. If the focus really is on "3D, multi-phased matter", then perhaps army ants are of no interest. But if the investigators really do want to extract general principles, then it seems worthwhile to acknowledge that we see milling in animals that are entirely blind (and thus have fewer sensory modalities to worry about) that move on a 2D surface.

Scientific Impact Comments: Most of my comments under "Technical Merit" addressed the areas of the literature that I thought were omitted from the proposal. However, some of those comments also addressed the scientific impact of this proposal. I'll add a few additional comments along those lines here. Beyond the objective of finding "design principles for engineered systems", the investigators spend a lot of time justifying further work on 3D tracking of bird flocks because they might help to reduce Bird/Aircraft Strike Hazards (BASH). This makes very little sense to me (bridging on laughable), and I would need more justification from the authors. How, EXACTLY, will this study help? Again, the response of a flock to a predator is likely precisely tuned to the speed and maneuverability (and size!) characteristics of both. Do we want to try to build human aircraft that fly such that birds can easily avoid them? Scaling hawks up to military and civilian aircraft size causes problems at the level of the Reynolds number as well as perception of the birds (let alone the comfort of the passengers diving into the flock in a maneuver designed to create the appropriate flash expansion). Let's just say that the authors find the right set of properties for a small aerial drone to fly ahead (as a kind of "advance team") of a large aircraft and "shape" the flock to move around the large aircraft to avoid a BASH. This seems not more complicated than the anti-radar masking maneuvers of cooperative UCAV's from the UAV literature a decade ago. But what about bird flocks that aren't starling like? And is your "advance team" of BASH-preventing drones going to have to identify which species of flock is ahead and act like the appropriate predator in the appropriate trajectory? Is this really what the investigators had in mind? The data is the main scientific impact of the proposed project. The rest is icing. Will we learn some new things about how to control large swarms of air vehicles? Maybe, but (as the investigators seem to imply themselves) the models and lessons inferred will probably be very similar to what we already know from starlings. So the main impact is data to help us determine the differences between starlings and Vaux's swifts.

Investigator Qualifications Comments: These investigators are highly qualified for this work. Cavagna has been closely involved with very closely related work with Starlings, being able to collaborate with statisticians, mathematicians, and engineers with complementary skills. This case is no different, as Cavagna has paired with other investigators with strong skills in movement ecology (Goodwin), ecology (Fischer), mathematics (Mellilo), and signal processing (Bennett, Jr.). Several of the investigators have a strong background looking at collective motion in animal systems, including birds but also including fish, and the others are no strangers to applying sophisticated analysis techniques to data from biological complex systems. I have high confidence that these researchers have the skills to complete such a project.

Recommend Research Comments: "Yes" is too strong of an answer, but "No" is too weak. I largely agree with the investigators that more data is needed about these animal aggregations. So I would be very happy if this group received funding and helped to provide some of that data. I am confident that the investigators will find some interesting new feature of this system that has not been observed before, but I



am less confident that the authors will advance the topology-vs-metric debate any further than it already is. The main deliverable of this project is it's data. All else will likely be forgotten.

Overall Assessment Comments: Overall, I'm underimpressed with the goals of this project. I think it has value because there have been few detailed high-resolution studies of the motion of these beautiful phenomena in nature, and so I would rather recommend this study for funding than not. But will we learn anything here that helps us design interesting and complex engineered systems? I'm simply not convinced of that. Now, if the authors do a thorough review of some of the behavioral ecology surrounding these ideas, then I think there are probably more interesting questions they can probe with their data. So there's certainly a lot of potential here. But for now, as it's written, it's just an extension of work that the authors have already done.

 **16ERDC\_Goodwin\_6.1-Proposal\_ActiveMatter\_ReducedSizeImages.pdf**  
8942K

**1. Name, Organization and Contact Information.**

Martin Siderius, Portland State Univ. (prime contractor), Portland, OR,  
[siderius@pdx.edu](mailto:siderius@pdx.edu)

Andrea Cavagna, ISC-CNR, Rome Italy - [andrea.cavagna@roma1.infn.it](mailto:andrea.cavagna@roma1.infn.it)

Stefania Melillo, ISC-CNR, Rome Italy - [stefania.melillo@cnr.it](mailto:stefania.melillo@cnr.it)

**2. Brief Statement of Qualifications, including:**

**a. Biographical sketch**

**Martin Siderius**, Director, Northwest Electromagnetics and Acoustics Research Laboratory (NEAR-Lab), Professor, Electrical and Computer Engineering, Portland State University, Portland, OR (503) 725-3223, <http://nearlab.ece.pdx.edu>

**Research Interests:** My background is in physics based signal processing methods. I develop remote sensing methods, most recently used for detecting, localizing and tracking marine life using underwater autonomous vehicles.

**Andrea Cavagna**, Senior Researcher, Institute for Complex Systems, National Research Council, Italy, +39-06 4993 7460; <http://www.cobbs.it/>

**Research Interests:** I am a theoretical physicist and I have studied for some years the statistical mechanics of disordered systems. In 2005 I began working on collective behavior in biological systems, trying to adopt methods from statistical physics to solve biological and ethological problems. I mainly work on collecting and analyzing empirical data about bird flocks and insect swarms.

**Stefania Melillo**, Tenure Track Researcher, Institute for Complex Systems, National Research Council, Italy, +39-06 4991 3689.

**Research Interest:** I was trained as an applied Mathematics and from 2010 I am the person in charge for the experimental and post-processing activities within A. Cavagna's team.

**b. Relevant past projects and clients with brief descriptions of these projects,**

Martin Siderius is the PI on several current projects that are relevant to this effort, for example:

- i) U.S. Air Force: *Bayesian Fusion of Heterogeneous Data for Unanticipated Event Detection*, STTR Topic FY16.A: AF16-AT12, 7/1/2016-present. Project will design, develop, test and demonstrate algorithms that fuse heterogeneous sensor data at an information theoretic level and process these data as detection and tracking algorithms that can identify when new events or targets emerge that are not currently modeled.
- ii) Office of Naval Research, Marine Mammals and Biology Program, *Applications of Density Estimation Methods to Datasets from a Glider*, 1/1/2013-present. The objective of this project is to evaluate the use of autonomous platforms, such as ocean gliders, for animal density estimation studies. Some advantages of using a glider for such studies include the acquisition and reporting of real time data, the *in situ* measurement of environmental information which is essential for density estimation calculations and bearing localization and tracking of various species.

Andrea Cavagna has led the following research projects:

- i) 2005-2007: local PI of STARFLAG (EU-FP6, 320K EUR);
- ii) 2010-2013: co-I of ARTSWARM (Italian Institute of Technology, 605K EUR) for

*the study of collective behavior in insect swarms;*

iii) 2010-2014: local PI of PANES (U.S. AFOSR, 400K USD) *for the study of collective behavior;*

iv) 2010-2015: co-I of SWARM (ERC EU-FP7, 1.1M EUR) *for the study of collective behavior in birds and swarms:* perform field experiment to collect 3D data on bird flocks and insect swarms.

The main aim of projects i)-iv) was the study of collective animal behavior in starling flocks and midges swarms in the urban environment of Rome, Italy, to understand the rules leading collective motions. Collected data were analyzed using statistical mechanics and control theory tools. Project iv) had the further aim of develop and implement the 4D tracking algorithm GreTA.

**c. Staff, faculty or students available to work on this project and their areas of expertise:**

The NEAR-Lab at Portland State has faculty, staff and students with a variety of experience relevant for this project. Personnel include: Lanfranco Muzi who has a PhD in Electrical and Computer Engineering and a MS in Computer Science, Elizabeth Kusel who has a PhD in Mathematics and extensive experience classifying and tracking marine life. The NEAR-Lab also has numerous graduate and undergraduate students that are pursuing degrees in Electrical and Computer Engineering. NEAR-Lab personnel regularly develop prototype systems (e.g., sensor systems, data acquisition systems) for terrestrial and underwater experiments. This project on understanding avian flocks has many potential topics for theses and research projects. More information can be found at <http://nearlab.ece.pdx.edu>.

**d. A brief description of capabilities to successfully complete the project. You may wish to add, e.g., existing unique and custom software and data appropriate for this investigation, equipment, laboratory facilities, field facilities, etc.**

Swifts will be video-recorded using a system of three synchronized high speed cameras and individual trajectories reconstructed using the tracking software GRETA, developed by ISC-CNR. Data will be analyzed from a statistical mechanics and from a modelling point of view, comparing if possible the findings on swifts with what has been previously found in starling flocks and midge swarms.

The NEAR-Lab and PSU are ideally located for staging the equipment and observing the swifts in Portland in September. The experience of NEAR-Lab personnel in field experiments will be crucial to design the experimental set up and to test the equipment.

The project will post-process data using GreTA, one of the most advanced 4d tracking algorithms. GreTA is able to successfully retrieve individual trajectories of thousands of animals, outperforming other state-of-the-art algorithms and producing 3d-trajectories with very low time fragmentation and few identity switches:

A. Attanasi, **A. Cavagna**, L. Del Castello, I. Giardina, A. Jelic, **S. Melillo** et al. (2015) *GRETA - a novel Global and Recursive Tracking Algorithm in three dimensions*, Transactions on Pattern Analysis and Machine Intelligence: (99), doi:[10.1109/TPAMI.2015.2414427](https://doi.org/10.1109/TPAMI.2015.2414427).

Dr. Siderius

Based on your Statement of Interest (SOI), we are pleased to announce that you have been selected to submit a full proposal for the project entitled: ***Understanding avian flocks near and entering civil infrastructure for species of concern.***

Please send your full proposal no later than January 18, 2017. If for some reason this date cannot be met, please contact me prior to noon on January 10, 2017 with your requested submission date. Therefore, please submit your proposal via email directly to me at [amanda.andrews@usace.army.mil](mailto:amanda.andrews@usace.army.mil). ALL CORRESPONDENCE REGARDING THIS ACTION WILL BE COORDINATED THROUGH THIS OFFICE.

Your full proposal should address how you plan to meet the objectives listed in the 'Request for SOI'; include a detailed budget, with supporting documents justifying each cost, taking into consideration the magnitude of anticipated funding and a total period of performance of 5 years. Information and constraints related to project funding are as follows:

1. tasks beyond those listed in the 'Request for SOI' that cause the total budget to exceed \$457,000 should be itemized and described. For example, such extra/supplemental tasks might include software improvements for analyzing Vaux's Swifts in geometric shapes that are challenging for existing methods that have worked well for Starlings and insects and/or software improvements that would permit the analysis of longer time blocks for Vaux's Swifts than has been accomplished for Starlings or insects.
2. total 4-yr funding (including all extra/supplemental tasks) cannot exceed \$548,000;
3. total 4-yr funding (including all extra/supplemental tasks) should preferably not exceed \$530,000.

We request your proposal cover all potential tasks and products for a 4-year study under two scenarios:

- **Plan A:** \$30,000 available January/February 2017 with the remaining total project funds (for all 4 years of work) available approximately June 2017 such that yearly budgets for Yr 1, 2, 3, 4 can vary however they need so long as the 4-yr sum does not exceed the total 4-yr funding from bulleted items 1-3 above;
- **Plan B:** \$30,000 available January/February 2017 with the remaining first and entire second 1-yr periods (Yrs 1 & 2) funding limited to \$80,000/yr. That is, a total of \$80,000 for Yr 1 and, more unlikely, a limit of \$80,000 for Yr 2 as well. Under this scenario, it is anticipated that the remaining balance of the total 4-yr funding from bulleted items 1-3 above would be distributed across Yrs 2-5 (i.e., period of performance) if there is a one-year 'delay' to full project funding and across Yrs 3-5 (i.e., period of performance) if there is a two-year 'delay' to full project funding.

Plan A is most likely, but we request a Plan B that allows the bulk of the work to start late by one year or, more unlikely, two years where these 'delay' years (1 or 2) would be used to execute other project tasks.

While we request a proposal for a 4-year study (with 5-yr period of performance), only the Yr 1 period (Plan A & B) tasks, product(s), and budget must be in sufficient detail for USACE to review/validate for award approval. Include your consideration of the following information that we would like incorporated into your proposal:

\* **MEETINGS:** The Recipient shall participate in project meetings with the staff of ERDC-EL to coordinate the plan of work, discuss progress, and resolve technical issues. Meetings will be held on mutually agreeable dates and locations or by telephone conference. Less formal interaction and collaboration will be conducted as needed.

\* **TRAVEL:** It is expected that personnel provided by the awardee will travel to and from the field on a nightly basis from late August to late September in Yrs 1-3 of the study if "Plan A" is executed and Yrs 2-4 if "Plan B" is executed. Any additional travel for project coordination or additional fieldwork will require modification to the contract.

\* **REPORTS AND DELIVERABLES:** The Recipient shall submit the following types of reports and deliverables. Reports and deliverables are to ensure that fund processing is timely and documentation supports financial interaction between our organizations. Reports and deliverables also document overall project accomplishments.

\* **Reports, Data, & Materials:**

(1) Semiannual Reports. If requested by the ERDC, one 1-2 page report on recipient progress should be submitted. No more than one such report will be required within each half fiscal year (Oct-Mar, Apr-Sept). At a minimum, the report shall contain an introduction section, and one section for each Task identified in your proposal. For each Task, the report shall summarize work accomplished for the Task. Other progress reports may be provided by the recipient, but are not required.

(2) Objectives, methods, requirements, and other relevant information for the full proposal are provided in the 'Request for SOI'. To re-emphasize some portions of the 'Request for SOI', the awardee along with ERDC personnel will collect measurement data on large flocks of Vaux's Swifts in twilight light conditions in Portland, Oregon at Chapman Elementary School and, possibly, elsewhere in the Portland metro area if the necessary permissions are not secured to conduct the measurements at Chapman. Under Plan A, measurements would be conducted in September 2017, 2018, and 2019. Under Plan B, measurements would start a year or, more unlikely, two years later and run through September 2020. The awardee will provide training to the ERDC on the technology and software used to measure bird flocks, and include the ERDC in all aspects of analyzing and publishing the results in the scientific peer-review journal literature. At least 3 scientific publications may arise from the project.

\* **PERIOD OF SERVICE:** Anticipated 5-year period of performance starting January/February 2017. Period of performance is 5 years regardless of whether Plan A or Plan B is executed.

\* GOVERNMENT PARTICIPATION:

Cooperative agreements require participation of both the Government and Recipient's organization. As described in the 'Request for SOI', ERDC-EL personnel will participate and collaborate with the awardee in all aspects of the project and publishing the results in the scientific peer-review journal literature.

\* BUDGET and JUSTIFICATION:

The full proposal must include a detailed budget. All proposed budget categories and corresponding amounts will be verified by contracting personnel. Submission of this information with the Full Proposal will expedite the award process. A detailed budget includes the following categories where applicable:

1) Salaries / Labor: This category should include a breakdown of the level of effort and rate for each individual proposed. Verification of all proposed rates must be provided in the form of payroll sheets or on university letterhead signed by the Office of Sponsored Programs/Business Office.

2) Fringe Benefits: Verification of all proposed rates must be provided in the form of payroll sheets or on university letterhead signed by the Office of Sponsored Programs/Business Office.

3) Travel: This category should include the following breakdown – number of travelers per trip, method of travel, departure/arrival destinations, numbers of days per trip, etc.

4) Material & Supplies: This category should include a breakdown of each item. Justification for all items will be requested in the form of an invoice or quote.

5) Equipment: This category should include a breakdown of each item. Justification for all items will be requested in the form of an invoice or quote.

6) Indirect Cost: Even though the CESU indirect cost rate is 17.5%, a copy of the university's official negotiated indirect cost rate agreement is requested.

\* OTHER INFORMATION:

Please ensure this full proposal has been reviewed and approved by the Office of Sponsored Programs and includes the tax identification, DUNS No. and CAGE Code this award is to be issued under.

## DESCRIPTION OF A 1 YEAR ACTIVITY - re. SOI W912HZ-17-0006

The aim of this 1 year activity is to practically solve some essential preliminary problems related to the experimental study of collective behaviour of Vaux's swift flocks in three dimensions.

In an effort to establish solid scientific links between the COBBS lab (Collective Behaviour in Biological Systems) at ISC-CNR and Near-Lab (Northwest Electromagnetics and Acoustic Research) at PSU, Dr Melillo (CNR) and Dr Siderius (PSU) conducted a pilot season of single-camera 2d data-taking in September 2016 on Vaux's swift at Chapman Elementary School, Portland. Preliminary analysis performed at the CNR end of these images demonstrate the feasibility of a 3D experimental study of this system. However, the images also show that flocks of Vaux's swifts at Chapman Elementary School perform a global rotational motion (around the chimney of the school) that is specific to Vaux's swift and that was absent in data analyzed by CNR in the past on different species (starlings). This rotational motion may prevent current 3D tracking algorithms from performing efficiently, if not jeopardize their functionality altogether.

The essential idea of every algorithm performing 3D tracking is to subtract from each individual motion the average global motion of the system, in order to minimize the distance covered between two frames by the individual. The simplest case is that of standard flocks characterized approximately by straight motion: in this case one subtracts the global flock's translation to the individual motion. This procedure is performed by all current algorithms directly on the 2d image, based on the idea that the 3d-to-2d projection of a translation is still a translation. However, this is no longer true for rotations, which change radically character when projected from 3d to 2d. A preliminary study conducted by CNR on the 2016 data shows that this phenomenon makes it very hard for the temporal linking to work on data of rotating swift flocks. More specifically, many instances of wrong linkage are produced, in which bird A at time  $t$  is linked to bird B at time  $t+1$ , giving rise to wrong trajectories.

The present 1-year activity will solve this issue through the following Work Packages:

**WP1. Estimate of the 3D rotational parameters.** Images collected in 2016 will be analyzed to get a rough estimate of the 3D rotational parameters. This will be done by translating 2d linear sizes in pixels into 3d linear sizes in meters by relating the average pixel size of individual swifts to their real biological body length (through the focal length of the lens). From this pixel-to-meters calibration we will be able to work out: i) the mean radius of curvature of the flock; ii) the amplitude of the rotational diameter; iii) the angular rotational speed; iv) the height of the rotating column. These parameters will be used as a 3d prior in developing the new temporal linking method.

**WP2. Modification of the temporal linking.** Once the approximate 3d rotation parameters have been worked out and validated, we will start the core of the work, namely developing a new temporal linking method. Targets will be directly reconstructed in the three dimensional space, where the optimal global motion of translation, rotation and dilation will be computed taking into account the rotational parameters measured in the previous step, and subtracted to the individual motion. This procedure minimizes the inter-frame distance covered by each individual, allowing temporal links to be univocally defined through the nearest-neighbour approach.

**WP3. Test on real and synthetic data.** All the modifications of the algorithm will be tested both on real and synthetic data. Tests on real data will be performed on starling flocks and midges swarms, comparing the old and the new temporal linking procedure in terms of quality of the

results of the entire tracking process. In order to validate the new method in the framework of the 3D tracking algorithms, we plan to apply the new approach on public benchmark datasets and on synthetic data reproducing standard flocking motion.

**Final deliverables:**

**D1. New temporal linking method.** The main deliverable of this 1-year activity will be the tested version of the new temporal linking method needed to study the dynamics of swift flocks under rotation. This new linking method will be embedded into the more comprehensive 3D tracking algorithm, making it a ready-to-use tool for any future 3D investigation of 3D swift flocks behaviour.

**D2. Technical report.** The work performed during this 1 year activity will be described into a 1-2 pages technical report to be submitted to ERDC. The report will specifically describe how the problem of 2d projection of the rotating motion of flocks has been solved and how the new dynamical linking method performs in test data. Moreover, this report will contain key recommendation on how to proceed for a full fledged 3D experimental study of swift flocks, should the opportunity arise to fund such project in the future.

**Resources employed:**

The work described above will be carried out by ISC-CNR in Rome and PSU in Portland, according to the following budget plan:

**1. ISC-CNR Total amount \$59,631:**

- a. Dr. Andrea Cavagna: 1 monthly salary= \$6,256.01; estimated working time= 3.24 months for a total cost of \$20,496.87; fringe benefits = \$163.19; project total= \$20,660.06.
- b. Dr. Stefania Melillo: 1 monthly salary= \$4,173.39; estimated working time = 8 months for a total cost of \$33,387.12; fringe benefits = \$163.19; project total: \$33,550.31.
- c. Indirect costs (overheads) for ISC: \$5,420.64.

**2. PSU Total amount: \$20,369\$**

- a. Dr Martin Siderius: estimated 1 month salary & fringe = \$13,506

**Total funded in this action is \$80,000.**