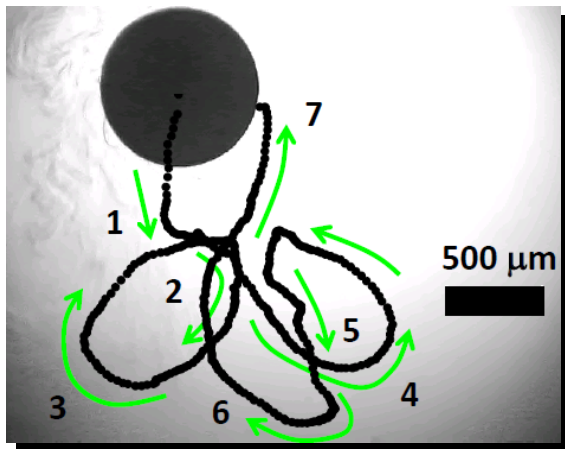
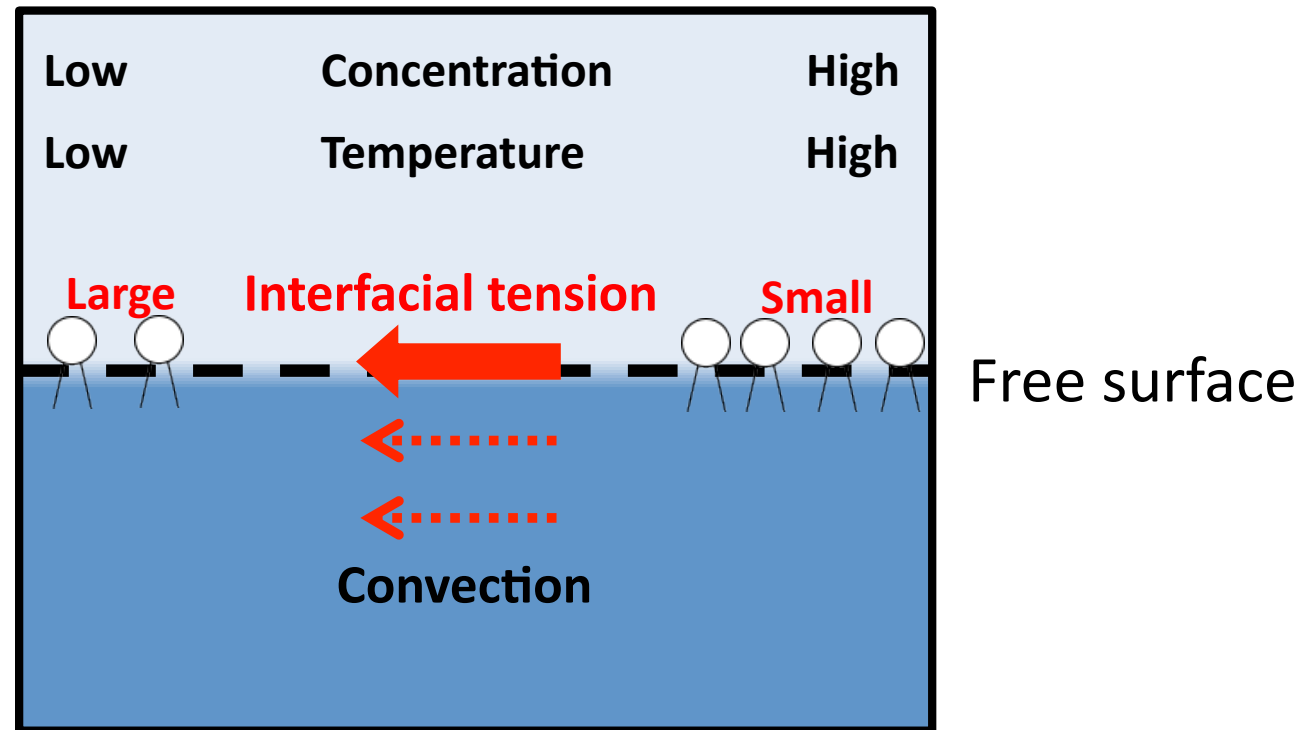


# Study on self-propelled droplet due to Marangoni effect



Okano laboratory

# Marangoni effect



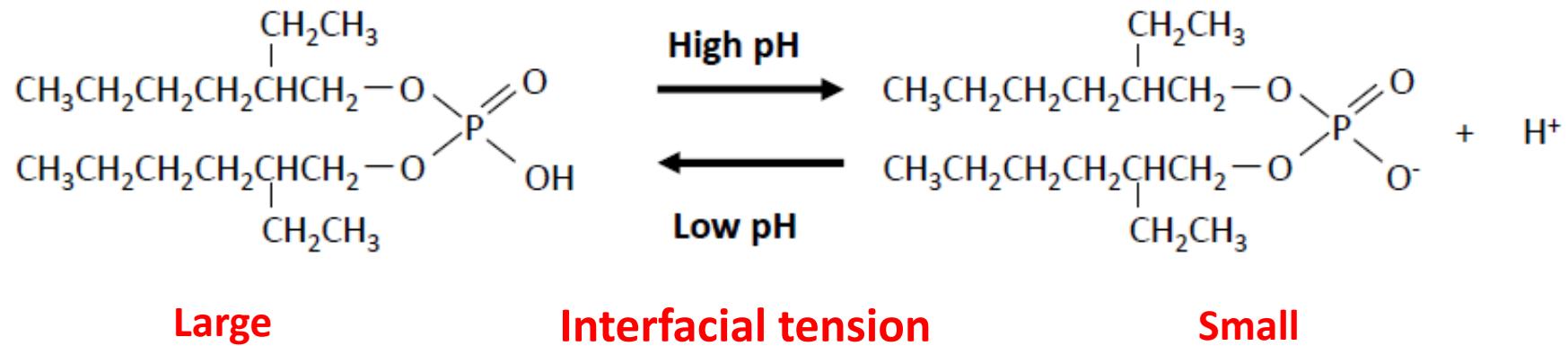
Difference of interfacial tension arises from concentration and temperature difference.



**Marangoni convection** is caused by the interfacial tension difference.

# Surfactant

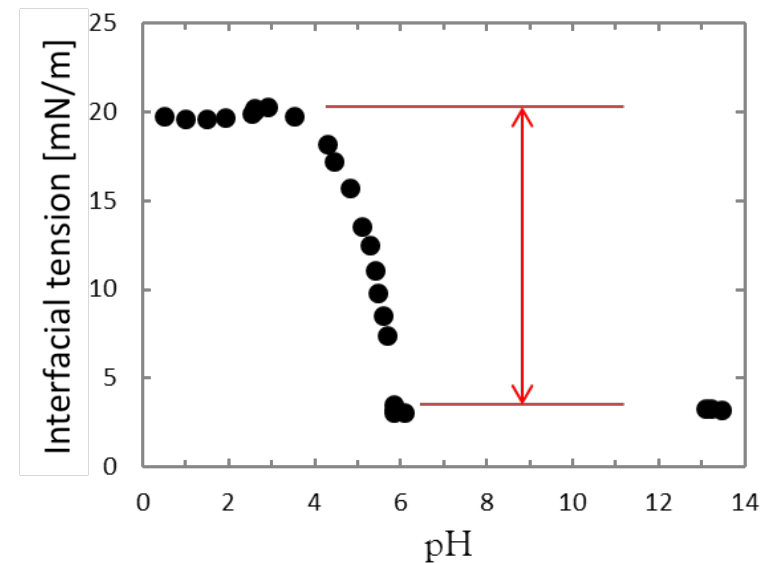
DEHPA (Di (2-ethylhexyl) phosphoric acid )



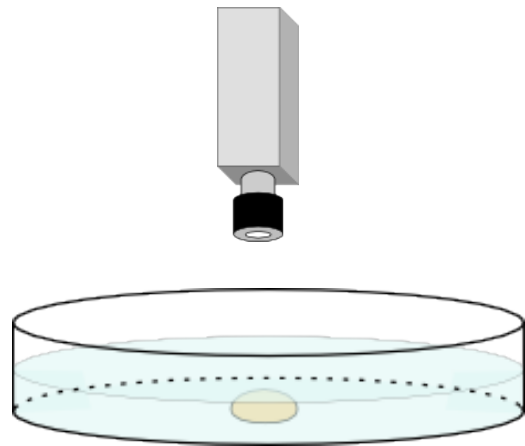
DEHPA deprotonates in high pH region.



Interfacial tension changes dramatically.

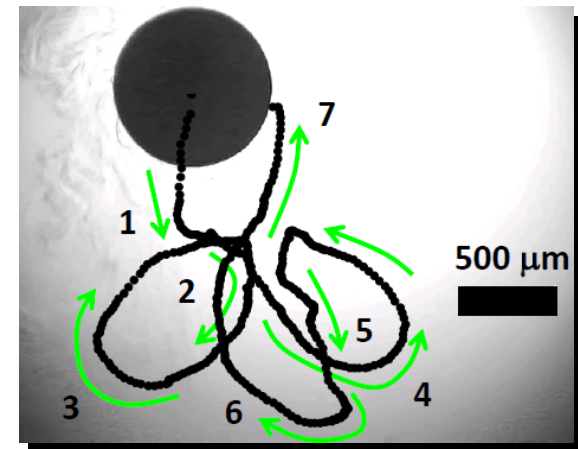


# Self-propelled droplet



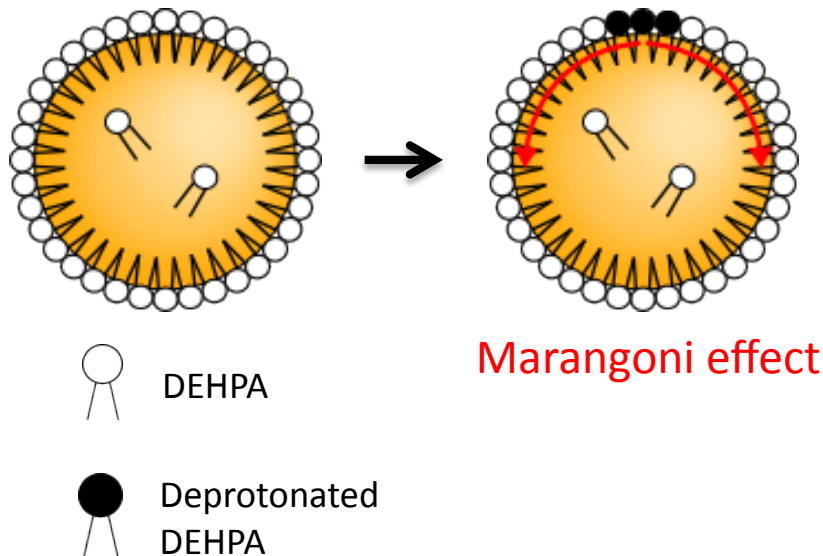
Oil droplet with DEHPA in aqueous solution

Self-propelled  
Random motion



Trajectory of droplet movement

## Mechanism of the motion



DEHPA deprotonates.



Interfacial tension changes locally.



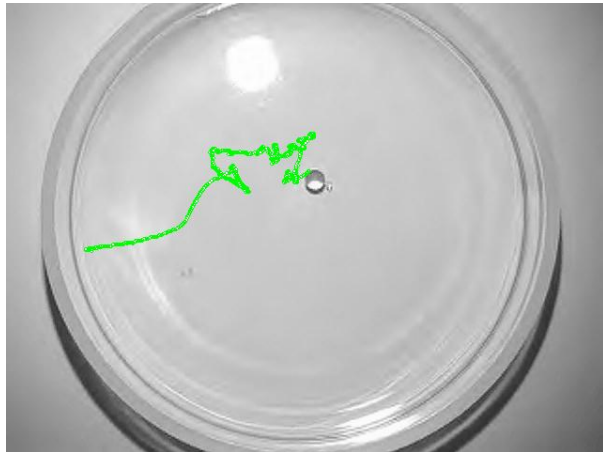
Marangoni convection is caused.



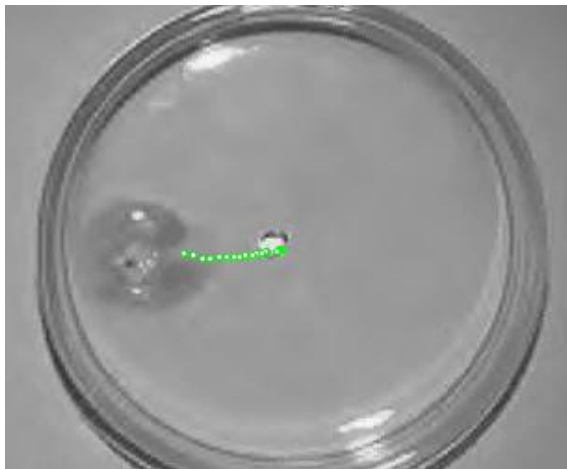
Droplet moves due to the convection.

# Functionality of droplet

Chemotactic property function

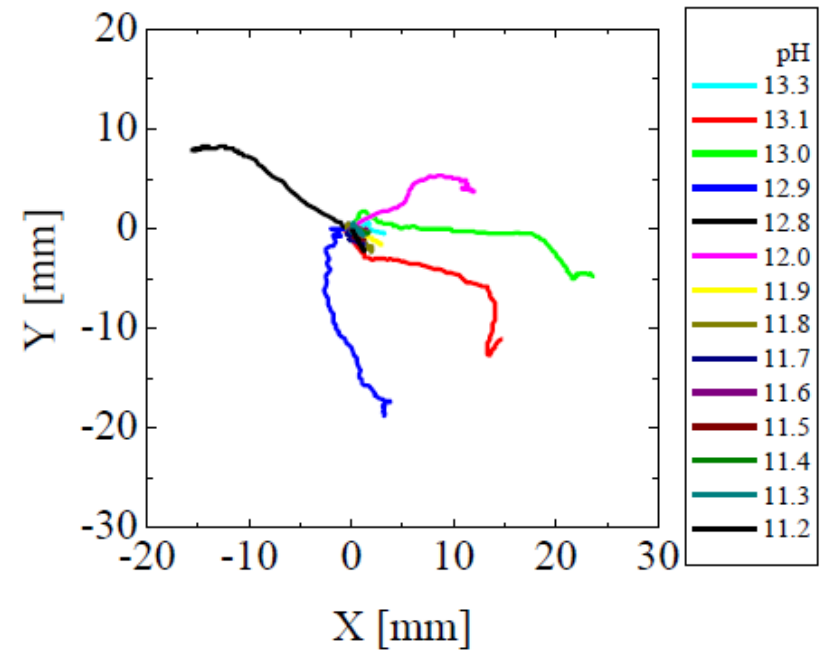


Random motion of droplet



Directionality to the metal ion

Switching function of droplet motion



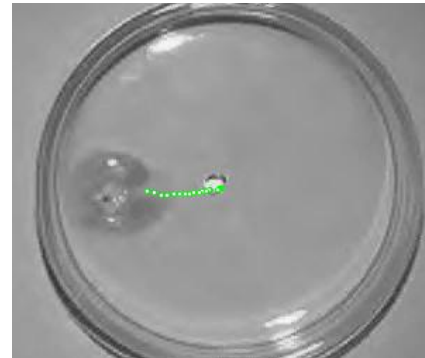
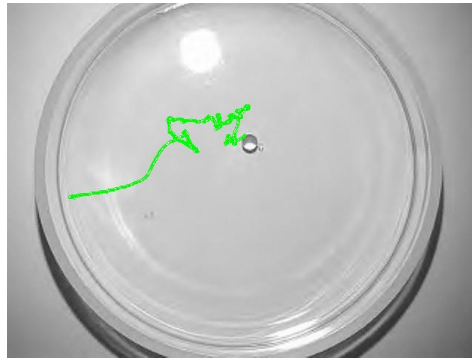
Droplet moves in specific pH region.



DEHPA has a affinity for metal ion.

## Our tasks

- To clarify the mechanism of the droplet motion in the presence of metal ions.



- To investigate the possibility of extraction into a droplet for rare earth.



1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57-71 ランタノイド	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-103 アクチノイド															
			57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr			

# Application

China



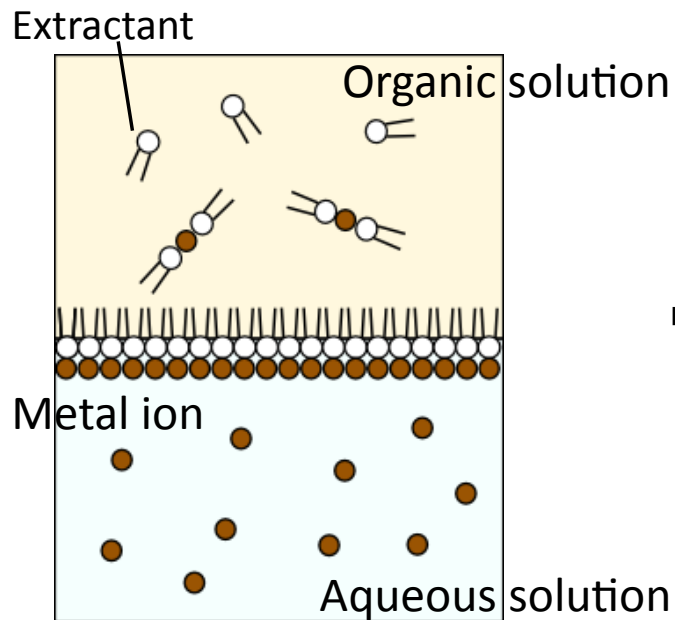
The world's largest rare earth producer

## Problems

- Rare earth mines also include radioelements.
- Extraction solvent causes ground pollution.

## Challenge

Technical development for autonomous extraction and separation of rare earth under poor working conditions



Solvent extraction separation

