**Supplementary materials for**

**Programmable active matter across scales**

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This supplementary materials file contains 1 supplementary table.

**Supplementary Table 1** **The force or energy of main interactions in colloidal systems**

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| --- | --- | --- | --- |
| Interaction type | | Force/energy | References |
| Magnetic  (Dipole-dipole) | | where is the magnetic moment of dipole *i*, ***r*** is the distance vector between dipoles. | (de Gennes & Pincus, 1970) |
| Electric  (Dipole-dipole) | | where is the electric dipole moment, are dipole relative angles | (Yan et al., 2016) |
| Hydrodynamic  interaction | Stokeslet | where is the charateristic size of the microswimmers, *r* is the distance, is the unit vector of the microswimmers major axis, is the unit vector of the distance | (Tan et al., 2022) |
| Force-dipole |  |
| Force-quadrupole |  |
| Source-dipole |  |
| Lift force | - | where *ri* is the size of the particle *i*; is rotating speed, *d* is distance and is the density of the fluid. | Grzybowski, Nature 2000 |
| Diffusiophoresis | Electrophoresis | where is concentration, *D* is diffusivity, is zeta potential; is solution viscosity;isdielectric permittivity. | (Ibele, Mallouk, & Sen, 2009; Velegol, Garg, Guha, Kar, & Kumar, 2016) |
| Chemophoresis |  |
| Capillary effect | Quadrupole-quadrupole | where is interfacial tension, is the angle between quadrupole *i* and the center line, is the amplitude of the undulation of the contact line, is the average radius and is the distance between two particles | (Danov, Kralchevsky, Naydenov, & Brenn, 2005) |
| Hexapole-hexapole |  |
| Multipole (mA)-multipole (mB) |  |
| DLVO theory | Two spheres | **Casimir-Lifshitz force**  A= is the number density of atoms, *D* the distance, the radius of colloidal cluster *i*, C the coefficient in the atom-atom pair potential.  **Electric double layer**  is Debye length, is interaction constant determined by surface geometry and electrolyte. | (Israelachvili, 2011) |
| Two flat surfaces | **Casimir-Lifshitz force**  **Electric double layer** |
| Sphere-flat surface | **Casimir-Lifshitz force**  **Electric double layer** |
| Interfacial tension-driven flow | | , mobility of particles; , activity of reaction on particle surface; | (Meredith et al., 2020) |

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