PHOTOPHORESIS-BASED LASER TRAPPING WITH A LINE OPTICAL TRAP

Alexey P. Porfirev, Sergey A. Fomchenkov
Samara National Research University, Samara, Russia

SAMARA NATIONAL RESEARCH UNIVERSITY,
443086, 34, Moskovskoye shosse, Samara, Russia
www.ssau.ru
e-mail. lporfirev@rambler.ru

The phenomenon of photophoresis in gases

Radiation

Gas molecules

Fast

Force

Slow

Warm

Cold

Force

Direct photophoresis
Rejection of particles via transferred photon impulses

Indirect positive (thermo-) photophoresis (for strongly absorbing particles)
Rejection of particles via excited gas molecules after warming due to light absorbing photon impulses

Indirect negative (thermo-) photophoresis (for weakly absorbing particles)
Resulting force in opposite direction because of transmitted and focussed light in semi-transparent particles

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Trapping airborne light-absorbing particles with a single optical beam

\[ F = G + R + F_{\text{ppT}} + F_{\text{ppa}} \]

- **G** is the gravity,
- **R** is the radiation force,
- \( F_{\text{ppT}} \) is the photophoretic force,
- \( F_{\text{ppa}} \) is a photophoretic force resulting from a temperature gradient,
- \( F_{\text{ppa}} \) is a photophoretic force resulting from a different thermal accommodation coefficient \( \alpha \)

Experimental setup for generating a line optical trap

- **Laser** is a solid-state laser (\( \lambda = 532 \text{ nm} \))
- \( L_1 \) and \( L_2 \) are the spherical lenses (\( f_1 = 50 \text{ mm}, f_2 = 100 \text{ mm} \))
- **M** is a mirror,
- \( L_3 \) is a cylindrical lens (\( f_3 = 25 \text{ mm} \))
- **MO** and **MO** are the microobjectives (\( N_A = 0.4, 20^\circ \), \( N_A = 0.2, 8^\circ \))
- **C** is a glass cell with airborne particles,
- **CCD** is a videocamera.

Experimental results: controlled rotating airborne particles

Rotation of the cylindrical lens around the axis leads to the rotation of the particles, which were trapped inside the line optical trap at a distance from its central part. At the same time, the particles trapped in the line optical trap on the beam axis did not rotate.

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