# Bridging the knowledge gaps in microplastics pollution

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MARLICE 2024

III International Forum on Marine Litter and Circular Economy

III Foro Internacional sobre Basuras Marinas y Economía Circular

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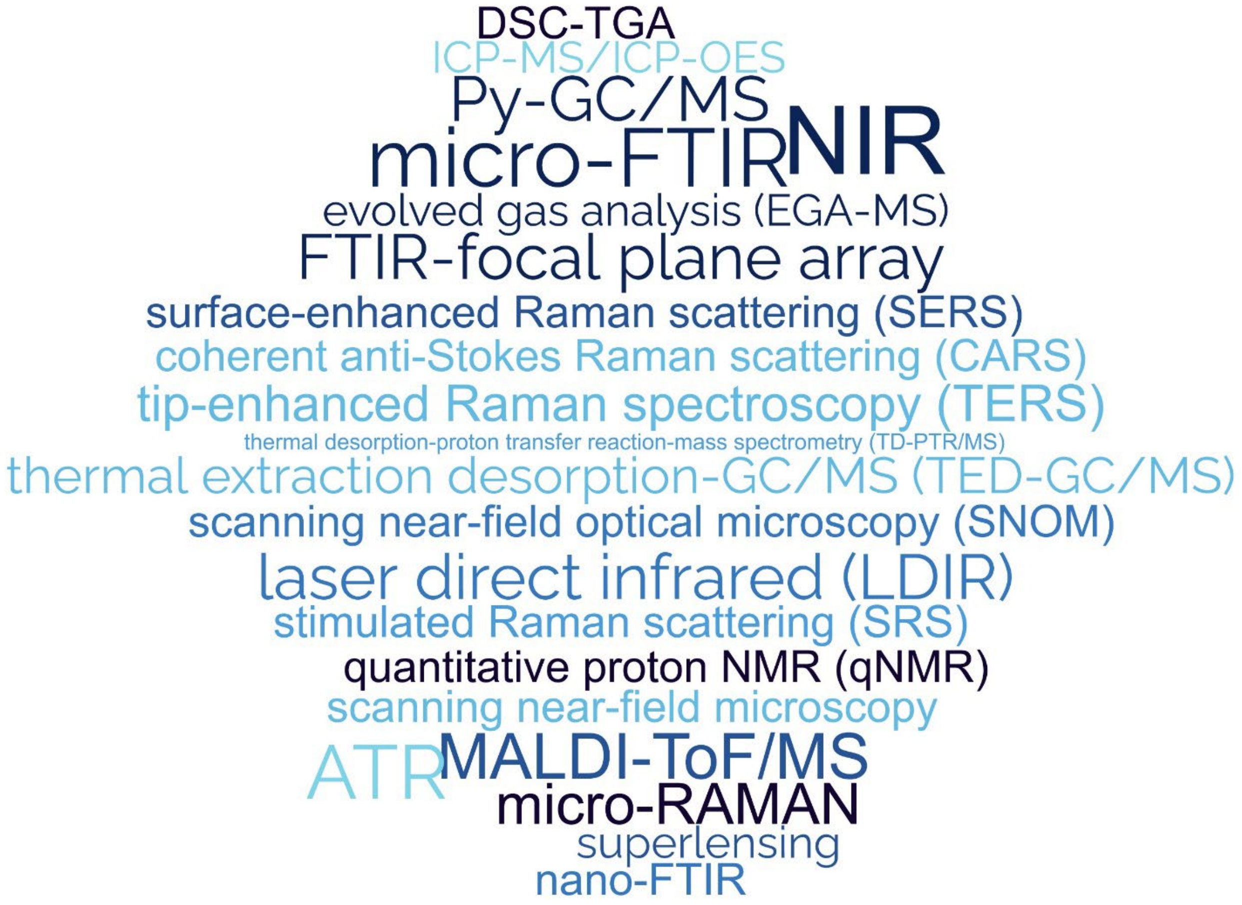


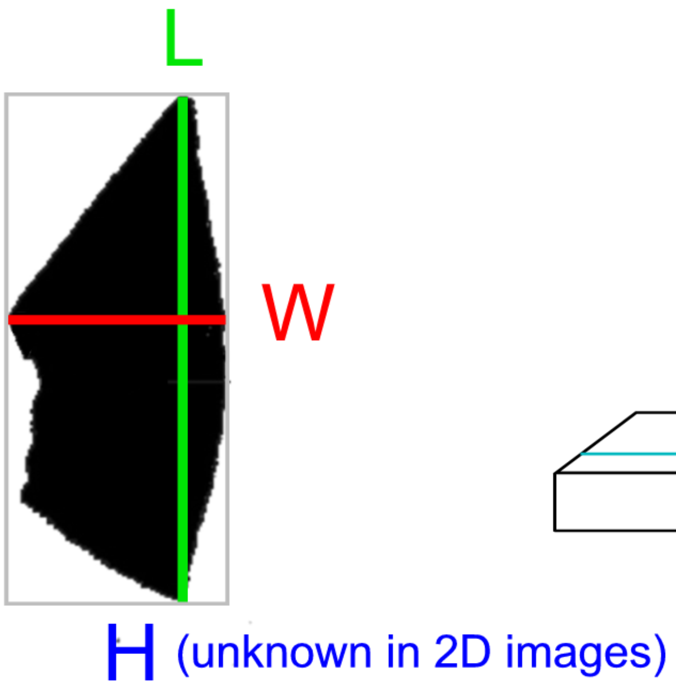

Analytical Techniques

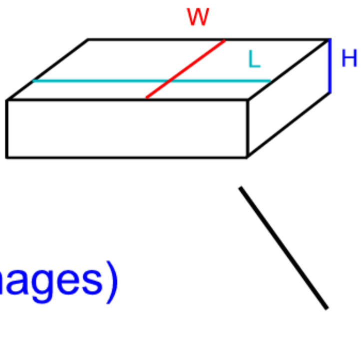

Methodological aspects

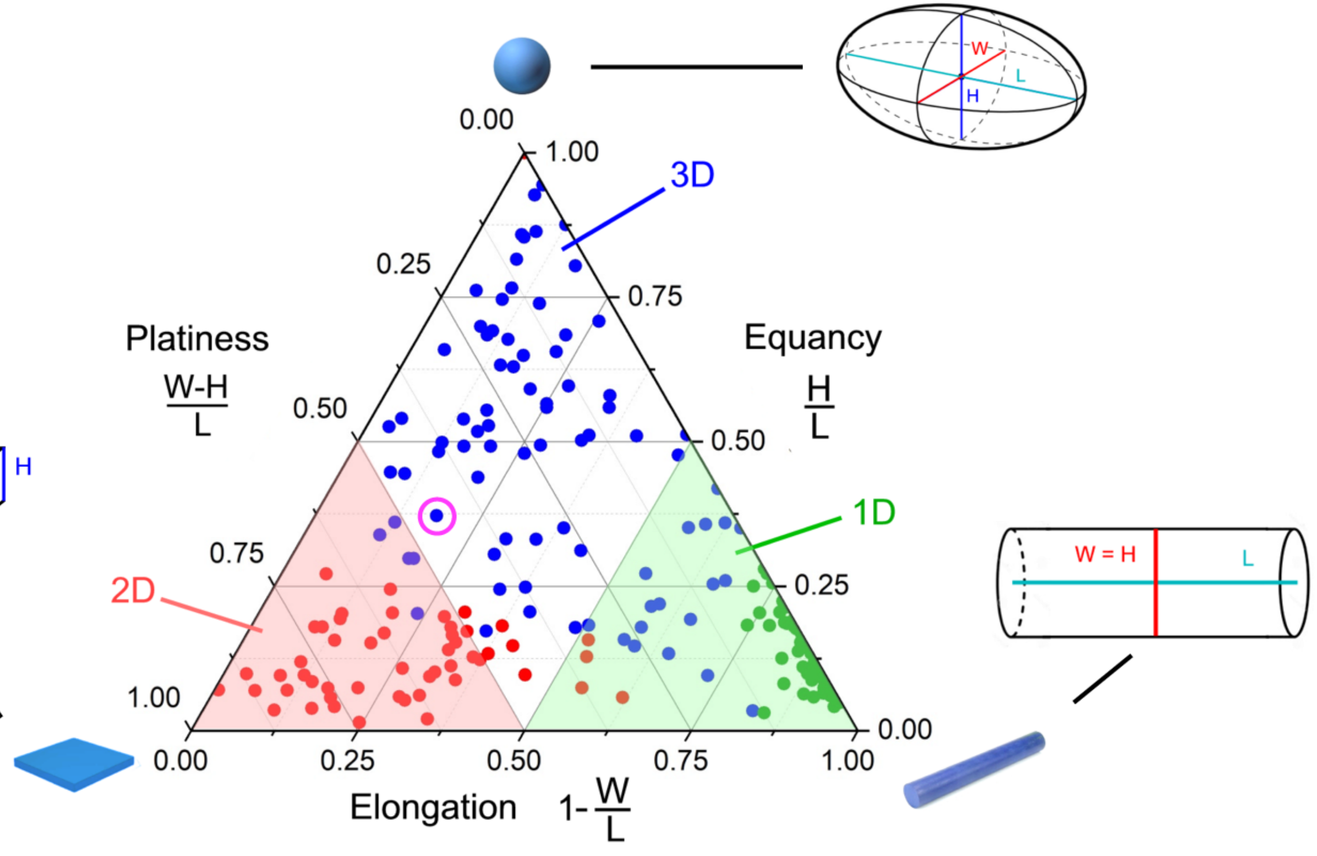
# Relevant (eco)toxicological data require mass concentration

Exposure verification, data reporting for effect thresholds

**Projected (2D) images** + Shape models = Particle volume
Particle volume + Density + Void fraction (if needed) = Mass of individual particles
Mass of individual particles + Subsample estimations = Total mass in a sample/subsample
Total mass in sample/subsample + Sample volume or mass = **Mass concentration**

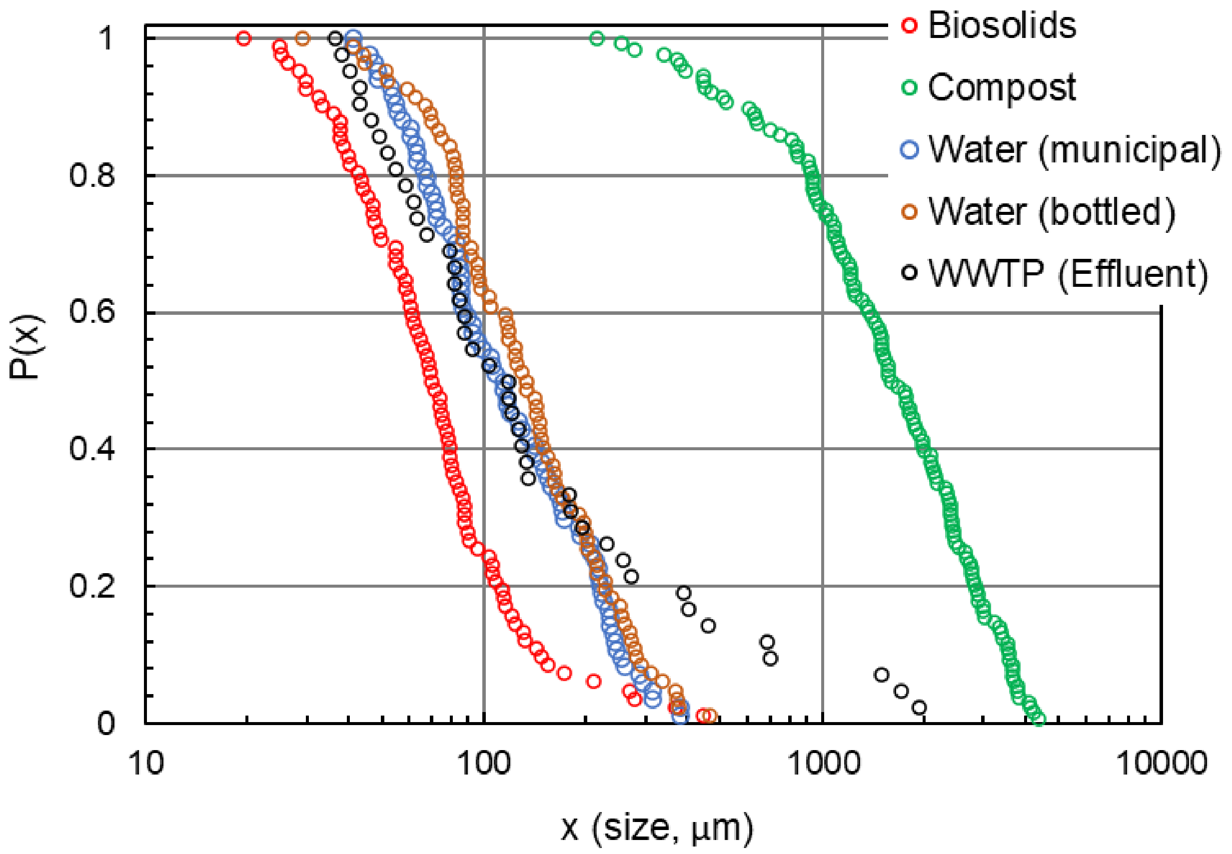



Simon's assuption: (H/W) = $(W/L)_{median}$

# Exposure estimation: particle counts versus mass concentration




**WWTP Effluent:**

A2O WWTP: 10.7 MPs/L = 15 µg/L
300 Million MPs/day = 430 g/day

**Biosolids:**

Dry sludge 183 MPs/g; dry pellets 165 MPs/g
In mass units 165 MPs/g = 135 µg MP/g biosolids
MP input to agricultural lands in Europe:
2-3 Mt x 135 µg MP/g = 270-400 t/year (other estimations 50 000 and 175 000 tonnes/year)

**Compost from OFMSW:**

5-20 MPs/g (separate collection) ~30 mg MPs/g
OFMSW 100 Mt; dry compost 32 Mt; x 30 mg MPs/g = 470 000-1 900 000 t/year (EU, only MPs)

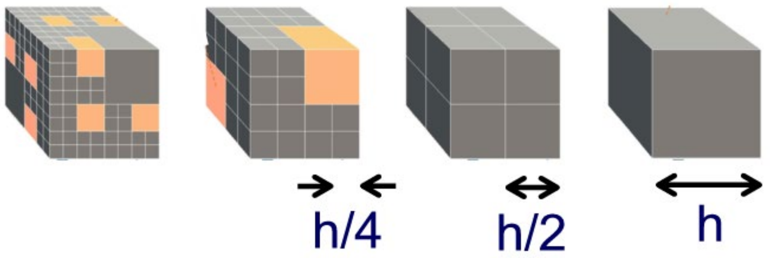
**Drinking water:**

Municipal drinking water: 12.5 (8.3-21.7) MPs/m$^3$, 18 ng/L, EDI: 0.5-2.2 ng kg$^{-1}$ day$^{-1}$ (2 L/day)
Bottled (PET): 0.73 (0.64-1.58) MPs/L, 1.61 (1.10-2.88) µg/L, EDI: 4-18 ng kg$^{-1}$ day$^{-1}$
**1 g in 10 years (bottled, 65 L/year) and 75 years (municipal 2 L/day)**

# Exposure estimation for small microplastics and nanoplastics

**Fractal fragmentation theories** allow rational estimations of mass concentration for sizes too small to be accurately measured.

In fractal theories, fragmentation depends on the probability «p» of crushing with crushing ratio «b». The number of fragments $N_i$ with size $x_i$ is given by:

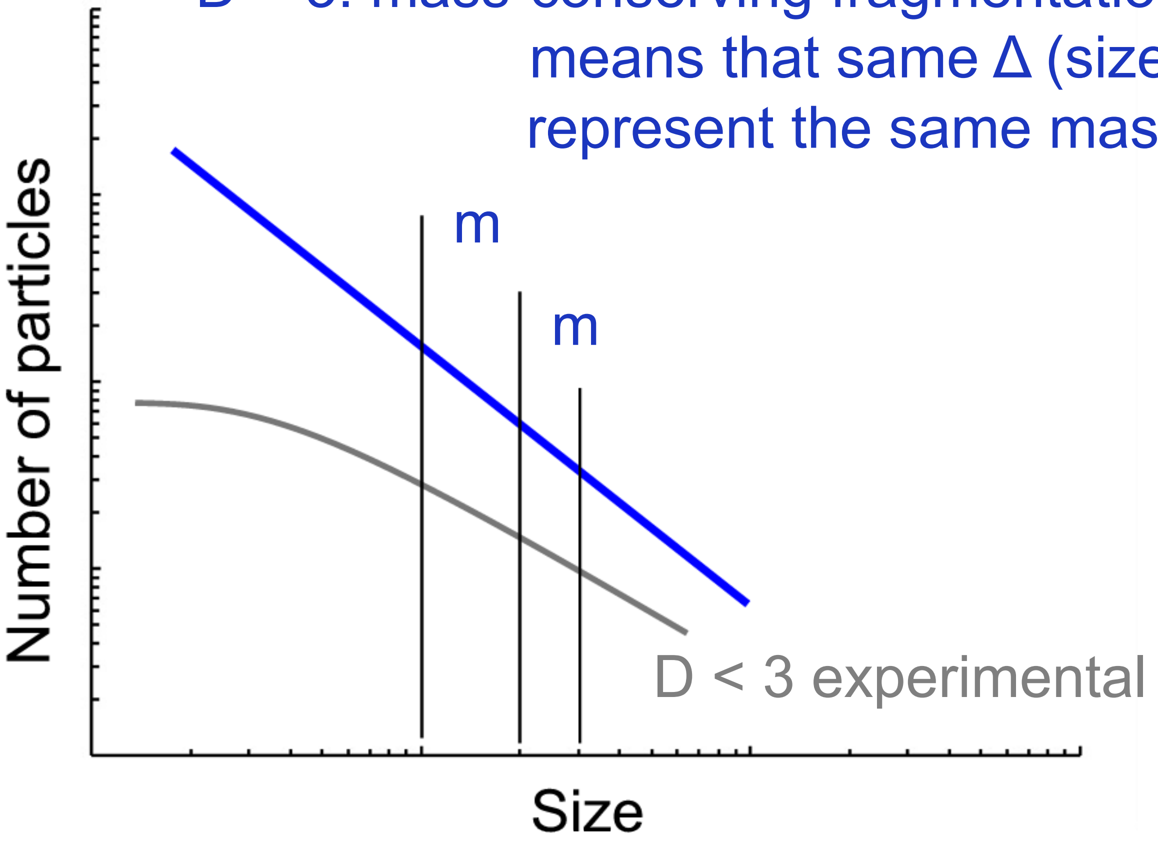



$$N_i = C\, x_i^{-D} \quad with\ D = 3 + \frac{\ln p}{\ln b}$$

log-log constant slope means scale invariance

D = fractal dimension identified with the dimensionality of the fragmentation process

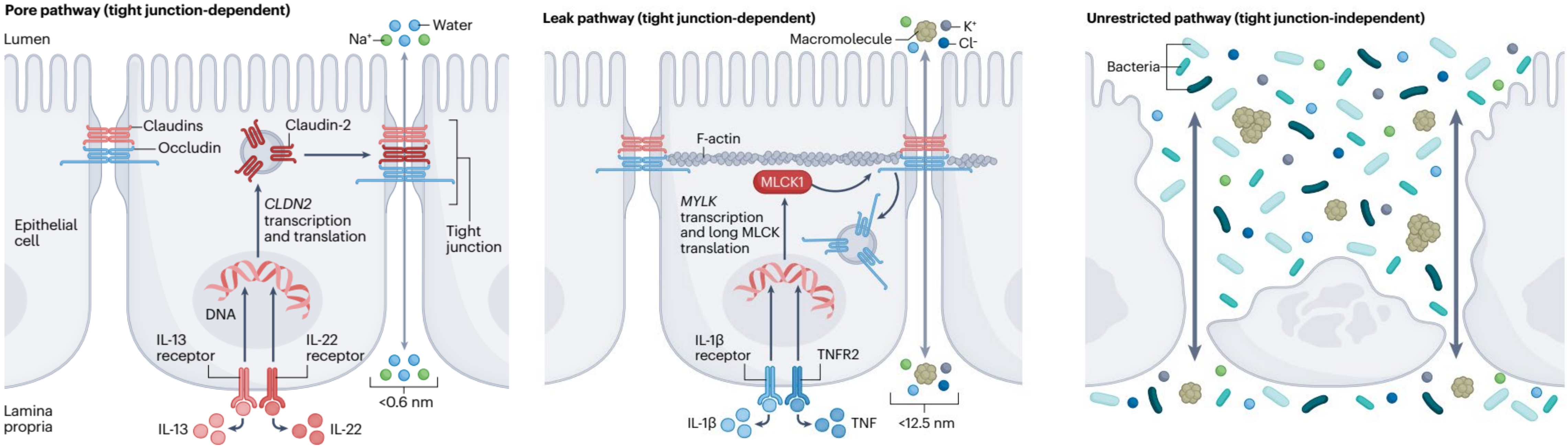
$$M_i = \int \rho \frac{\pi}{6} x_i^3 \left(C\, x_i^{-3}\right) d\,x = \rho \frac{\pi}{6} C\, \Delta x_i$$



# Risk assessment

1 **Precise exposure estimation** is needed for nanoplastics, additives, NIAS (oligomers), and polymer degradation products (including textiles and bioplastics)

2 **Internalization mechanisms** should be clarified




3 Accurate **exposure-effect (hazard)** information is required for **modelling risk** meaning broader range of endpoints with attention to sublethal and chronic effects and interactions with other stressors + **other hazard related aspects** are trophic transfer, particularly in agroecosystems and interaction with the biota (ARG, ARG, pathogens)

# Key issues - important gaps

1. Accurate exposure estimations needed in mass units
2. Detailed information on internalization mechanisms
3. Exposure-effect information suitable for risk assessment
4. Possible trophic transfer and human exposure trough food products
5. Fate of polymer degradation products, especially for new products such as bioplastics
6. Interaction with microorganisms