Relationship between spectral particulate attenuation and particle size distribution

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Introduction:

• Particle Size Distribution (PSD):
  Information about the ecological dynamics of marine water, particulate sedimentation fluxes and sediment transport;

• Beam attenuation coefficient (C):
  Quantify light propagation in the ocean and to study the concentration of the material affecting light propagation.
PSDs could be well approximated by a hyperbolic (Junge-like) distribution:

\[ N(D) = N_0 (D/D_0)^{-\xi} \]

- \( N(D) \): the number of particles with diameters between \( D \) and \( D + dD \) divided by \( dD \);
- \( D_0 \): reference diameter;
- \( \xi \): PSD slope varying between 3 and 5.
The particulate attenuation $c_p$:

$$c_p(\lambda) = c_p(\lambda_0) \lambda^{-\gamma}$$

The exponent of the particulate attenuation spectrum ($\gamma$) and the exponent of the PSD ($\xi$) are linearly by

$$\gamma = \xi - 3$$

([Diehl and Haardt, 1980]);

The main goal of this study is to test that relationship.
Methods: $C_p$

$$C_p = C_{pg} - C_g$$
PSDs: Coulter Counter

3-10 $\mu m$ range used: avoid noise in the small size range ($2<D<3\mu m$); the scarcity of particles $>10 \mu m$ made statistical very bad.
Results:

1. Optical Data:
Super mixed water !!!
Fitted $C_p$ Curves:
Fitted PSDs Curves:

![Graph showing fitted PSDs curves with particle diameter on the x-axis and number concentration on the y-axis. The graph includes a red line with markers labeled "AB surface sample".]
## Comparison: $\xi$ for Two Different Particle Size Ranges and Spectral Slope $\gamma$

<table>
<thead>
<tr>
<th></th>
<th>$C_p(440)$</th>
<th>$\xi$ for $2&lt;D&lt;10\mu$m</th>
<th>$\xi$ for $3&lt;D&lt;10\mu$m</th>
<th>$\gamma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB surf</td>
<td>0.6575</td>
<td>7.8273</td>
<td>3.4445</td>
<td>0.4861</td>
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<tr>
<td>AB 10m</td>
<td>0.6575</td>
<td>9.8067</td>
<td>3.2151</td>
<td>0.484</td>
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<tr>
<td>CD stn1</td>
<td>3.7436</td>
<td>3.32</td>
<td>3.5679</td>
<td>0.608</td>
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<tr>
<td>CD stn2 surf</td>
<td>4.098</td>
<td>2.9453</td>
<td>3.7722</td>
<td>0.6998</td>
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<tr>
<td>CD stn2 10m</td>
<td>4.098</td>
<td>2.8565</td>
<td>3.4784</td>
<td>0.6998</td>
</tr>
</tbody>
</table>
Theoretical and measured relationship:
Conclusions:

• The shapes of the particulate attenuation spectra \( c_p(\lambda) \) were found to be well approximated by a power law with respect to wavelength;

• A single Junge exponent was found not to match very well the whole data from 2 to 10 \( \mu m \); a better fit was found when the size range was limited to \( 3 < D < 10 \mu m \);

• The range of observed values of \( \xi \) and \( \gamma \) is relatively consistent with the linear relationship: \( \gamma = \xi - 3 \).