THE CLOUD CHAMBER

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THE CLOUD CHAMBER

• The role of the Wilson Cloud Chamber is often forgotten in the modern annals of the development of particle physics.

• Up until 1952, when the Bubble Chamber was invented by Donald Glaser, scientists relied on the the Cloud Chamber for the photographic investigations of fundamental processes.

• Rutherford describe the cloud chamber as "the most original and wonderful instrument in the scientific history"

"Seeing is believing"

Aerosol Science and Technology 32:243-248 (2000), "Historical Review of Coulier, Aitken"
Rev. Mod. Phys. 18, 225 - 290 (1946)
Phys. Rev. 51, 818 - 825 (1937), "Alpha Particles from Uranium"
Cloud Formation and Airborne Dust - the fog

- Airborne Dust known ca.1869, by optical techniques. Tyndall, Brownian
- Pioneers, Coulier(ca. 1875), Aitken (ca. 1880) showed the importance of airborne dust particles in the air in the formation of clouds.
- "Fine solid particles suspended in the air are necessary for the production of fogs". Coulier
- More than 200 tons of sulfur was burned with coal every winter in London in the 1880's -> "London Fog".
- Lord Kelvin and JJ Thompson (ionization) made important contributions to the theory.

FIGURE 1. The apparatus used by P. J. Coulier for the studies on water vapor condensation (Coulier, 1875a).
In Wilson's original design ca. 1911 a diaphragm expanded to rarify and bring the vapor+air mixture into a supersaturated state.

Wilson's original chamber acted very slowly and more advanced designed soon followed.

For rare nuclear or cosmic events triggered or rapidly cycled chambers were developed.

Rudiments of stereo photography was developed.

Some continually sensitive chambers based on diffusion were developed ca. 1940.

A saturated vapor diffused between a warm to cold plate in the chamber.

The sharpness of the tracks suffered in such devices.
The Blacklett/Occhialini chamber could be triggered upon the passage of a cosmic ray.
Alpha Particles from Uranium - UI and UII

Table I. Summary of most important range determinations.

<table>
<thead>
<tr>
<th>Method</th>
<th>Range in Air @ 13°C 760 mm</th>
<th>Investigator</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ionization</td>
<td>2.53 cm 2.91 cm</td>
<td>Geiger-Nuttall¹</td>
<td>1912</td>
</tr>
<tr>
<td>Pleochroic Haloes</td>
<td>2.82 cm 2.91 cm</td>
<td>Gudden²</td>
<td>1924</td>
</tr>
<tr>
<td>Wilson Chamber</td>
<td>2.73 cm 3.28 cm</td>
<td>Laurence³</td>
<td>1927</td>
</tr>
<tr>
<td>Scintillations</td>
<td>2.72 cm 3.23 cm</td>
<td>Rutherford⁴</td>
<td>1927</td>
</tr>
<tr>
<td>Wilson Chamber</td>
<td>2.72 cm 3.28 cm</td>
<td>Kurie⁵</td>
<td>1932</td>
</tr>
</tbody>
</table>

¹ H. Geiger, J. Nuttall, Phil. Mag. 23, 439 (1912).
² W. Hubert, Zeit. f. Physik 26, 110 (1924).
³ G. C. Laurence, Phil. Mag. 27, 690 (1914).
⁴ E. Rutherford, Phil. Mag. 4, 580 (1927).
⁵ F. Kurie, Phys. Rev. 41, 701 (1932).

\[ U_{92}^{238} \rightarrow Th_{90}^{234} + \alpha_2^4 (4.2\text{MeV}, \text{UI}) \]
\[ \rightarrow X_{91}^{234} + \beta_{-1}^0 + \overline{\nu} \]
\[ \rightarrow U_{92}^{234} + \beta_{-1}^0 + \overline{\nu} \]
\[ \rightarrow Th_{90}^{230} + \alpha_2^4 (\sim 4.7\text{MeV}, \text{UII}) \]

\[ U_{92}^{235} \rightarrow Th_{90}^{231} + \alpha_2^4 (4.5\text{MeV}) \]

Fig. 1. Reproduction of typical chamber photograph, showing tracks of various types and ages.

Fig. 2. Track length distribution for uranium alpha-particles.
THE DIFFUSION CLOUD CHAMBER

• The diffusion cloud chamber was developed in 1936 by Alexander Langsdorf.
• Alcohol wicks up to the top and then diffuses down to a cold base plate.
• A supersaturated layer forms near the bottom - sensitive to ionization.

http://www.andrews.edu/services/physicsenterprises/products/diff_cloud_cham.html
THE CLOUD CHAMBER DEMO

http://-andrews.edu/services/physicsenterprises/products/product_demos.html

Diffusion Cloud Chamber Manual
(Model 500 and 600)

Includes the following:
Cloud Chamber
12V DC Power Supply and Cable
Water Circulation Pump
2 Rubber Hoses
Extraction Pipette
Source Holder and Stopper
High Voltage Connecting Cable
Coupon for Pb 210 Source Needle redeemable from Spectech™

• Cold water must flow when Peltier Device powered on.
• Alcohol should be removed from the chamber after use - opened and aired.