Emmy Noether

Reformer of Modern Algebra

1882 - 1935

Biography

- Born on March 23th, 1882 in Erlangen (Germany) as Amalie Emmy Noether
- Father Max Noteher was professor of mathematics at the University of Erlangen
- Emmy was the first of 4 children, she had 3 brothers
- Descended from a Jewish family
- Brother Fritz Noether flew from the Nazis to the Soviet Union, but was shot for accusation of anti Soviet propaganda during the Great Purg
- In 1900, received a diploma as English and French teacher for schools reserved for girls
- Continued her studies and graduated in Nürnberg in 1903
- In 1903, enrollment at University of Erlangen for mathematics
- Received her Ph.D in 1907, with Paul Gordan as her supervisor
- She worked several years (in Erlangen and in Göttingen) without being paid and lived frugal with the help of her heritage
- The math faculty of Göttingen approved in 1915, after a controversial discussion, her demand to habilitate which was declined by the public administration in 1917
- Finally in 1919, the University of Göttingen allowed Noether to proceed with her habilitation
- Strong scientific relationship with David Hilbert and Felix Klein
- Officially works as *assistant* of Hilbert
- Guest professor in Moscow (1928-29) and Frankfurt am Main (1930)
- In 1933, emigration to the US due to the Nazi's political takeover
- The Nazi regime dismissed Jews from university
- Died on April 14th, 1935 at the age of 53

Contributions

- First woman to receive the German habilitation
- Second German woman receiving a Ph.D in mathematics at a German university
- One of the most important women in the history of mathematics
- In 1932: Ackerman-Teubner-Memorial-Award with Emil Artin for their contributions to mathematics
- One of the founders of modern algebra
- In 1932: Plenary address on "Hyper-complex systems in their relations to commutative algebra and to number theory" at the International Congress of Mathematicians in Zürich (high point of her career)

Missing Recognition

- Not elected to the Göttingen Gesellschaft der Wissenschaften (academy of sciences)
- Never promoted to the position of *Ordentliche Professorin* (full professor)
- No payments for her teaching until 1923

Quotes

- David Hilbert related to her demand for habilitation: *After all, we are a university, not a bath house.*
- *If one proves the equality of two numbers* a *and* b *by showing first that* a *is less than or equal to* b *and then* a *is greater than or equal to* b*, it is unfair, one should instead show that they are really equal by disclosing the inner ground for their equality.*

References

1. https://en.wikipedia.org/wiki/Emmy_Noether
2. https://nothersfight.weebly.com/emmys-work.html
3. http://www.sjsu.edu/faculty/watkins/noetherth.html
4. http://www.math.ucr.edu/home/baez/noether.html
5. https://awm-math.org/awards/noether-lectures/

Emmy Noether Lecture

- Initiated by the Association for Women in Mathematics (AWM) in 1980
- Honors women who have made fundamental and sustained contributions to the mathematical sciences
- Special additional Emmy Noether Lectures in 1994,1998 and 2002 at the International Congress of Mathematicians (ICM)
- Became in 2010 a permanent ICM tradition, called (additional) ICM Noether Lecture

Noether's Theorem in a Nutshell

Theorem: *If the Lagrangian function for a physical system is not affected by a continuous change (transformation) in the coordinate system used to describe it, then there will be a corresponding conservation law; i.e. there is a quantity that is constant.*

Suppose we have a particle moving on a line with Lagrangian $L(q, q')$, where q is its position and $q' = dq/dt$ is its velocity. The momentum of our particle is defined to be

$$p = dL/dq'.$$

The force on it is defined to be

$$F = dL/dq.$$

The equations of motion say that the rate of change of momentum equals the force:

$$p' = F.$$

Next, suppose the Lagrangian L has a symmetry, meaning that it doesn't change when you apply some one-parameter family of transformations sending q to some new position $q(s)$. This means that

$$\frac{d}{ds} L(q(s), q'(s)) = 0.$$

Then Noether's theorem claims that $C = p \cdot dq(s)/ds$ is a conserved quantity, that is, $C' = 0$.

Portrait

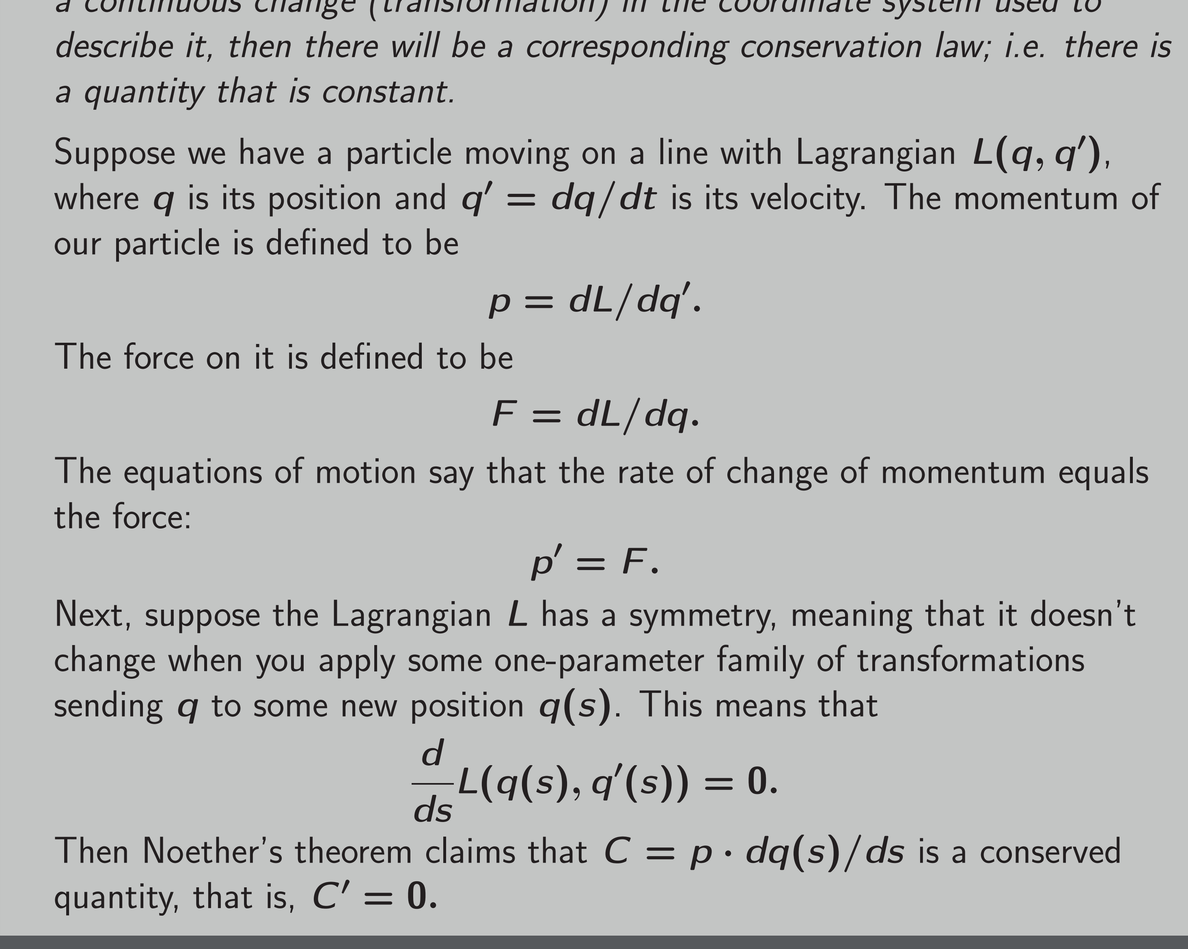

Figure 1:Emmy Noether

Noetherian Rings

A *Noetherian ring* R is a commutative ring that satisfies the ascending chain condition on ideals: Given any chain of ideals,

$$\mathcal{I}_1 \subset \cdots \subset \mathcal{I}_{k-1} \subset \mathcal{I}_k \subset \mathcal{I}_{k+1} \subset \cdots,$$

there exists a n such that:

$$\mathcal{I}_n = \mathcal{I}_{n+1} = \cdots.$$

Examples:

- Artinian rings (satisfying the descending chain condition on ideals)
- Dedekind domains (including rings of integers)
- Principal ideal rings (including Euclidean domains)