About a new Nanoparticle Mass Measurement Method in the Transition Regime

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Content

- Innovationstheses
- Invention: Nanoparticle Mass Measurement
  - Principles
  - Applications

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Innovation?

Innovation is **ability** to **depict** unthinkable **processes** with existing ones

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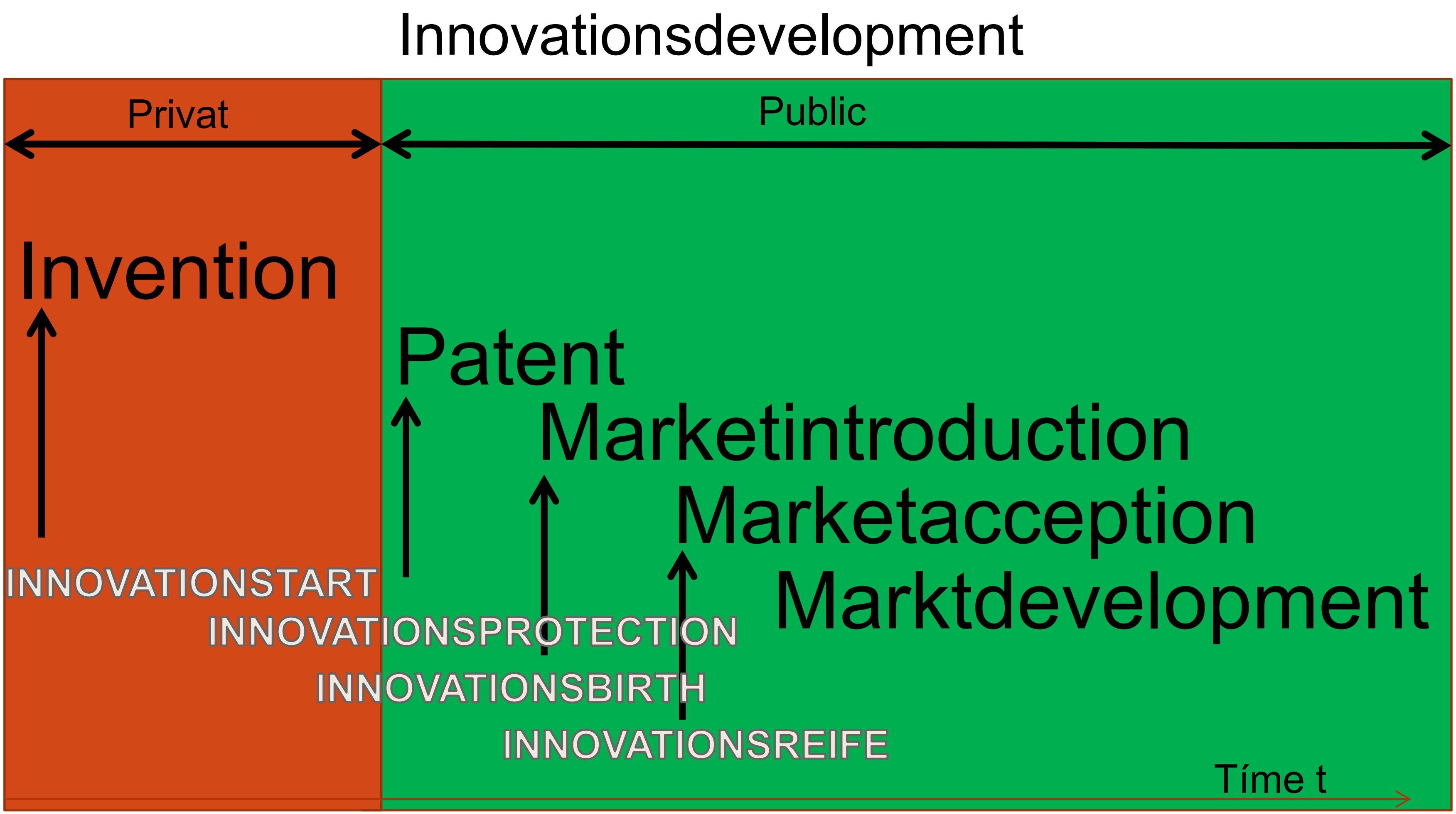
Innovationsprocess II



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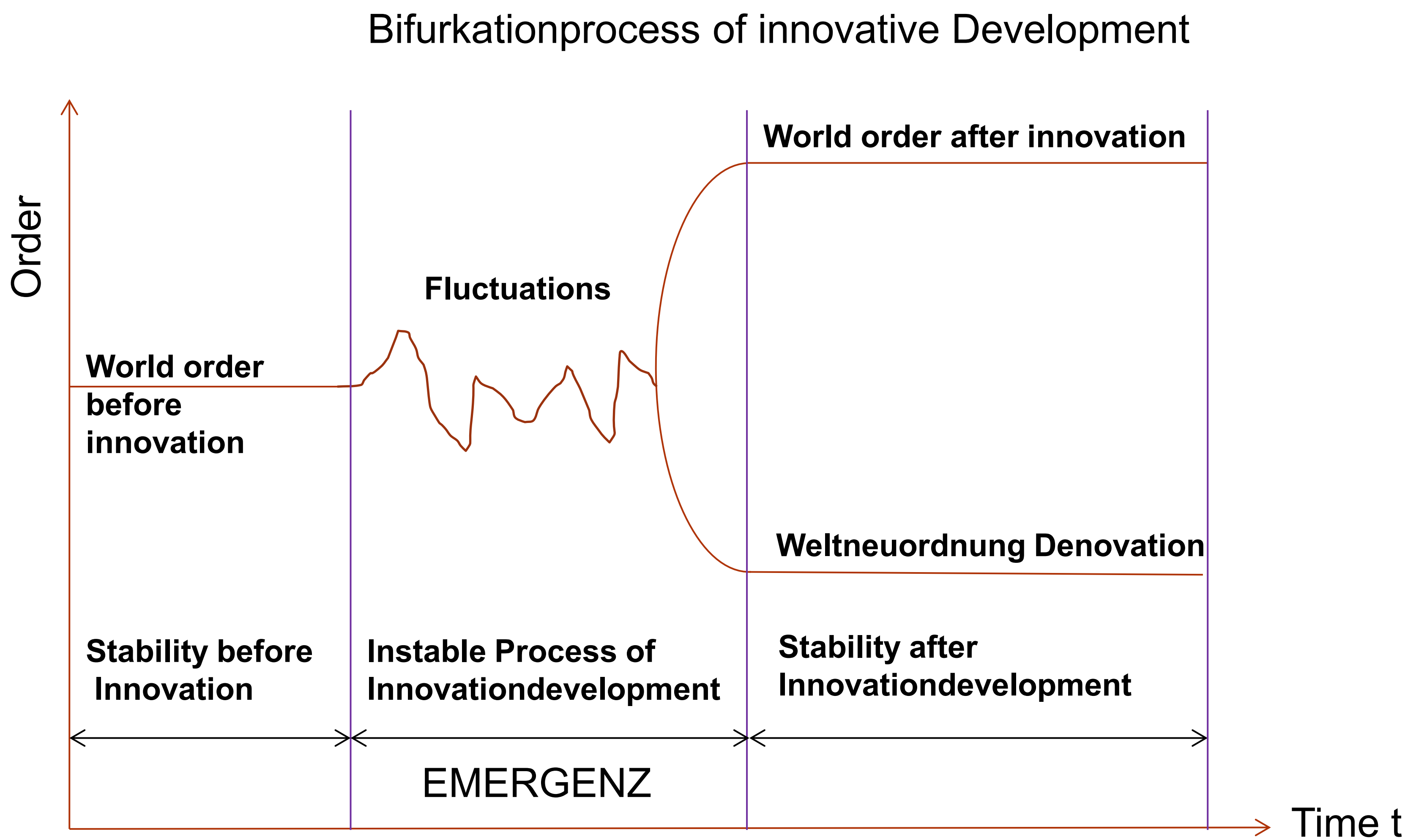
Innovationsprocess III
Innovation as Bifurkation



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CONCLUSION INNOVATION-S-PROCESS

(I) Innovation is **ability** to **depict** unthinkable **processes** with existing ones

(II) **Innovationsdevelopment** goes from invention over patent and marketintroduction to inovationmaturity by marketacception

(III) Innovation as bifurkationprocess is worldorderdestabilization which by innovationsdevelopment – when successful – leads to a **generativ** **new order**. Higher order in evolutive sense means better environmentadaptation for humanity

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How do we prepare best for the innovationsprocess?

(1) Thinking the **Unthinkable**

(2) On the **border of best now** existing **knowledge**

(3) What cannot be said ‚does not exist' – the speech ist the border of our world (Wittgenstein, tractatus)

(4) Aerosol Technology → Technology is the speech of the engineer & Technology is applied science

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Bsp.: Europaweites Entwicklungsumfeld

AWS – first
RSI backgaranty
contract
→Support of
**innovative
enterprises**
→**Opposite Trend
to to Basel
Criteria**

aws unterzeichnet europaweit erste RSI-Rückgarantievereinbarung für innovative Unternehmen

Die Austria Wirtschaftsservice GmbH (aws) ist die erste Förderbank Europas, die mit dem European Investment Fund (EIF) eine Rückgarantievereinbarung im Rahmen des „Risk Sharing Instrument" (RSI) unterzeichnet. Damit erleichtert die aws innovativen österreichischen KMU und mittelständischen Unternehmen den Zugang zu Finanzierung.

v.l.n.r.: Richard Pelly, Chief Executive des European Investment Fund mit aws-Geschäftsführer Bernhard Sagmeister in Wien // Fotocredit: AWS/APA-Fotoservice/Hinterramskogler

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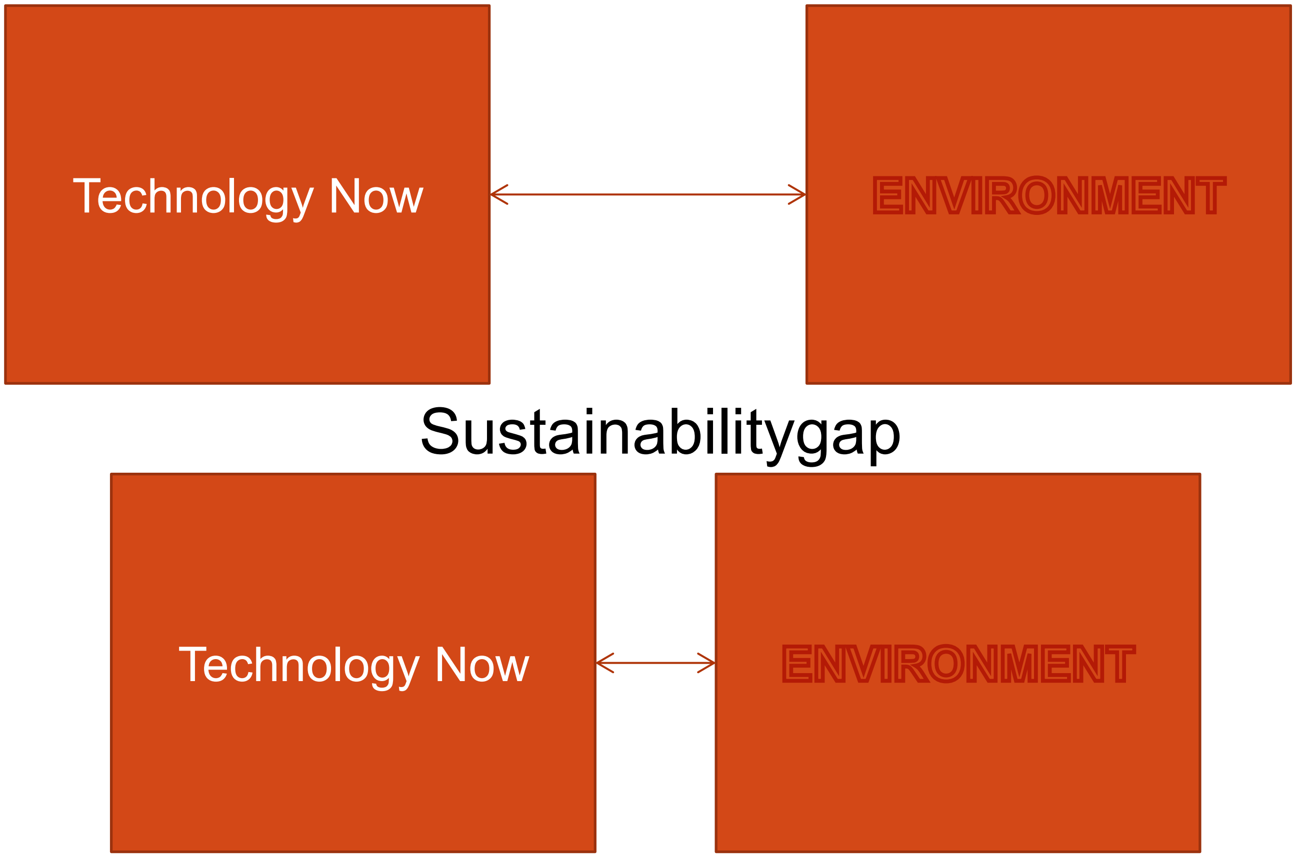
(Aerosol-)Productiontechnologies of the Future

Focus of Research



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(Aerosol-)Productiontechnologies of the Future

Theses

Context of **Discovery** and Context of **Justification** come closer*

Axiom 1

→ Research and Application come closer to each other: When **researching application** has to be considered simultaneously

→ Cooperation of Universitys becomes more important; Systemic Task: Closing the gap of application and research

→ Shorter Learning time

→ Technology becomes more important

*** Basic Thesis of Theory of Science**

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Problem

In which phase are particles in the transition regime: Are they fluid or solid?

→One approach: Measure the mass?

- →But when measuring mass they could be evaporated

- →Solution: Measurement of the density IN SITU

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In Situ Nanoparticle Measurement Device

*Invention 2003
*Austrian Patent Application 2012-11-28, A1252-2012

Patents that have be found similar:

D1: WO 2008005283 A2 (SIONEX CORPORATION et al.) 2008-01-10 (Fig. 22; Seite 6, Zeilen 20-30; Anspruch 1)
D2: WO 2008129039 A2 (FERNANDEZ DE LA MORA et al.) 2008-10-30 (Seite 23, Zeilen 12-26; Ansprüche 14,15)
D3: US 2010031734 A1 (ZHANG et al.) 2010-02-11 (Anspruch 19)

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Formulas

FORCES:

$$F_g = m_p \cdot g = \frac{4}{3} r_P^3 \cdot \pi \cdot \rho_p \cdot g \qquad (1)$$

$$F_e = q \cdot \vec{E} \wedge \vec{E} = \frac{U}{d} \qquad (2)$$

$$F_w = 6 \cdot \pi \cdot \eta \cdot r_P \cdot v \qquad (3)$$

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Formulas

$$F_w = F_{e_{DMA1}} + F_g \qquad (4)$$

DMA1

$$F_w = F_{e_{DMA2}} - F_g \qquad (5)$$

DMA2

Insertion gives:

$$6\pi \cdot \eta \cdot r_P \cdot v = q \cdot \vec{E}_1 + \frac{4}{3} r_P^3 \cdot \pi \cdot \rho_p \cdot g \qquad (6)$$

$$6\pi \cdot \eta \cdot r_P \cdot v = q \cdot \vec{E}_2 + m_P \cdot g \qquad (7)$$

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Formulas

The last two equations added and substracted give the following two equations:

$$12\pi \cdot \eta \cdot r_P \cdot v = q(\vec{E}_1 + \vec{E}_2) \quad (8)$$

MILLIKAN …

$$0 = q(\vec{E}_1 - \vec{E}_2) + 2 \cdot m_P \cdot g \quad (9)$$

This can be **interpreted** as system of two equations consisting with two unknowns m_p and r_p:

$$m_P = \frac{(\vec{E}_2 - \vec{E}_1) \cdot q}{2 \cdot g} \quad (10)$$

$$r_P = \frac{(\vec{E}_2 + \vec{E}_1) \cdot q}{12\pi \cdot \eta \cdot v} \quad (11)$$

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In Situ Nanoparticle Measurement Device

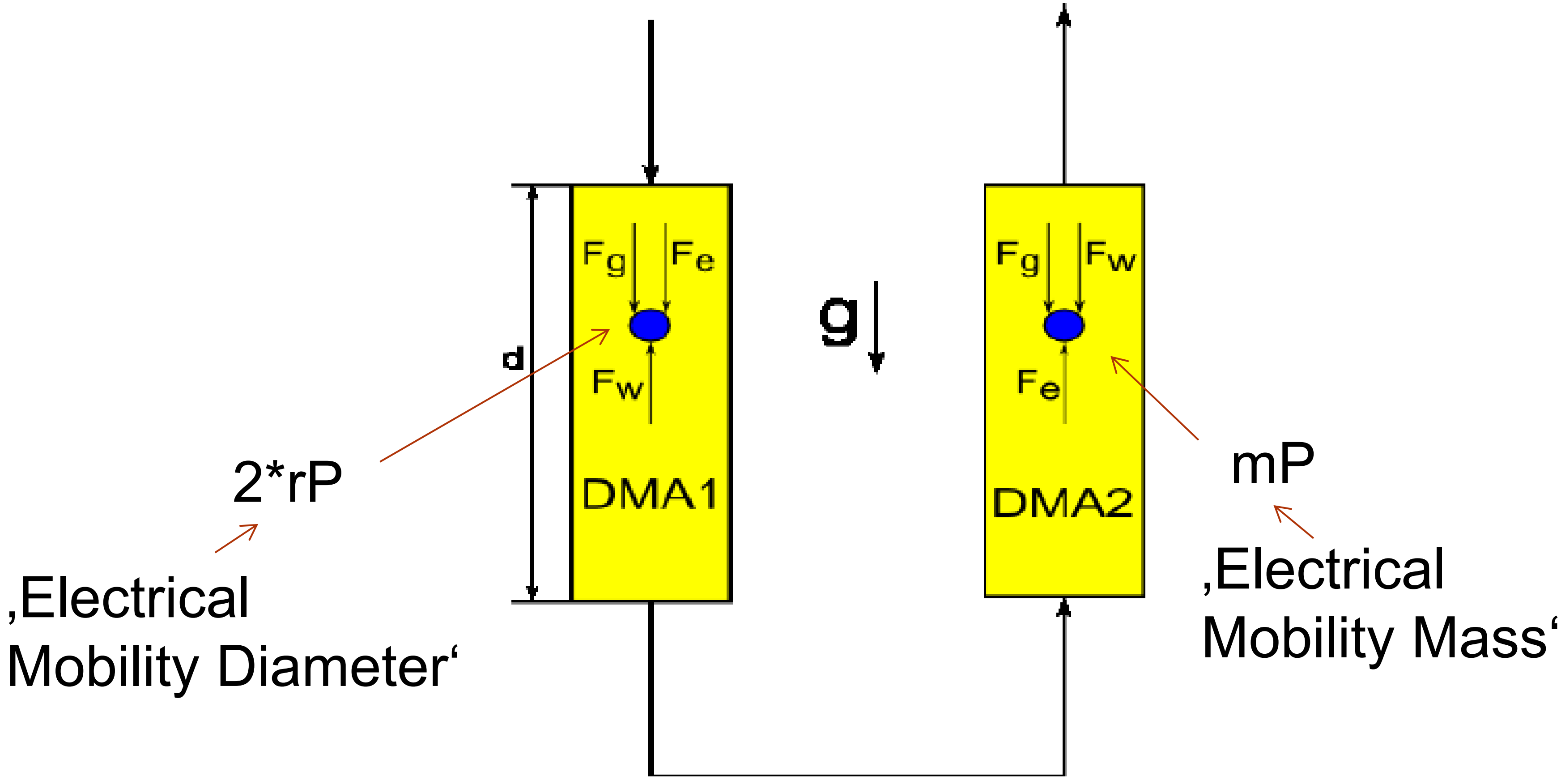

Figure 1. Two Differential Mobility Analyzer (DMA's) in opposite direction with respect to the gravitation vector g and forces for balance.

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Example

For the application of the particle mass measurement method a short example is given:

One Particle have the mass $m_P = \frac{4}{3} r_P^3 \cdot \pi \cdot \rho_p \cdot g$. In this case the fractal aggregate consisting of primary particles has a density of $1,8 g/cm^3$. The fractal aggregat, consisting of primary particles of same size, has the density of $0,02 - 0,06 g/cm^3$. The diameter d is $80nm$, the particle density is then $0,04 g/cm^3 = 40 kg/m^3$. With this according to $m_p = 4/3 \cdot (d_p/2)^3 \cdot \rho_p \cdot \pi$ results in particle mass $m_p = 1,072 \cdot 10^{-20} kg$. With electron charge $e_0 = 1,602 \cdot 10^{-19} A \cdot s$ the electrical field is

$$\Delta \vec{E} = \frac{m_P \cdot 2 \cdot g}{e_0} = \frac{1,072 \cdot 10^{-20} \cdot 2 \cdot 9,81}{1,602 \cdot 10^{-19}} = 1,313 V/m \qquad (12)$$

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Example

This can be interpreted in this way that the particle is charged with one electron is in equilibrium with an electrical field of 1,313 V/m and is unlevered in the gravitational field.

Let us take as granted the 'lowest voltage step', or the smallest resolution or possible voltagedif-ferenz of the hight voltage source of the DMA is $0,1526V$ with a DMA of length $0,61m$ which is in accordance with particlestreamingdistance in one DMA, related to the difference of both of the electrodes of the DMA is $d = 0,5m$ then follows $\vec{E} = U/d$ and with this $\Delta U = \Delta\vec{E} \cdot d$ and so $\Delta U = 0,657V$, that means this is the voltage of the DMA with that the particle will be unleverd and only particles of smaller mass of the mass measurement device can pass it - meaning both DMA's in antiparallel order.

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Example

Now we can get the mass of the next smalle particle in the mass measurement device with the calculation of a DMA voltage diminuated by the 'smallest voltage step'. With this we

get the next smaller diameter dp_1 with new voltage $\Delta U_1 = 0,504V = 0,675V - 0,1526V$ and with this $\Delta \vec{E}_1 = 1,009V/m$ and then the mass of $m_{P1} = 8,237 \cdot 10^{-21} kg$ and a radius $r_p = 36,63nm$ repectively a diameter of $d_{P1} = 73,3nm$. This gives measurement accuracy of 9% of measurement value with relation to diameter. Analogous there is a mass difference for both particles of $\Delta m_{P1} = 2,48 \cdot 10^{-21} kg$ or rounded 30% minimal procentual difference of both particles of the example which is identical with mass measurement accuracy.

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Conclusio

It ist now possible to measure the nanoparticle mass on the ‚fly'

→ You need two DMA's which are antiparallel to the acceleration vector respective the gravitational vector

→ With the measument method you get a mass distribution

→ By means of density characetrisation, which is possible as particle diameter and mass are measured consequently is possible

→ This way you get three distributions in one, Numbersize, Numbermass and Numberdensity

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Herzlichen Dank für die Aufmerksamkeit!