“Let's have a look!”
Observations, theories, philosophical troubles

Dr. Nicola Mößner
“Look, alternative facts are not facts. They’re falsehoods.” (Chuck Todd at NBC Meet the Press)
Facts are facts...

- Facts in international politics
  - Shaped by social dynamics
  - Embedded in social institutions
Facts are facts...

- Facts in international politics
  - Shaped by social dynamics
  - Embedded in social institutions

- Facts in science
  - Alan F. Chalmers: scientific statements are regarded as particularly reliable because science is based on facts
  - What about the influence of social dynamics and social institutions in this context?
  - Are scientific facts better off with this regard?
Facts are facts...

- Why ask a philosopher of science?
- Philosophy as a *meta-discipline*
  - Socrates: *I know that I know nothing*.
  - Going *beyond the obvious*, i.e., going beyond commonly accepted ideas - think critically!
Facts are facts...

• Why ask a philosopher of science?
• Philosophy as a meta-discipline
  – Socrates: *I know that I know nothing*.
  – Going *beyond the obvious*, i.e., going beyond commonly accepted ideas - think critically!
• Philosophy of science as meta-science
  – Critical analyses of *epistemic practices*
  – What are facts in science like?
  – What about social dynamics and institutions in this context?
Contents

- What are scientific facts?
- Observation and observability
- What is theory-ladenness of observation?
- Social dynamics in science
What are scientific facts?

• What are scientific facts?
  – Facts – evidence (indicators) – data
  – Results of experiments and observations
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  – Facts – evidence (indicators) – data
  – Results of experiments and observations

• Why do we need reliable facts in science?
  – Two tasks of scientific hypotheses (theories): explanation and prediction (of phenomena)
  – Testing of scientific hypotheses: falsification or confirmation
What are scientific facts?

predicts

Scientific hypothesis

Data
What are scientific facts?

- Scientific hypothesis predicts Data
- Data tests (falsify / confirm) Scientific hypothesis
What are scientific facts?

Data

Scientific hypothesis

predicts

test (falsify / confirm)

Data

Scientific hypothesis

explains

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What are scientific facts?

- Scientific hypothesis predicts Data
- Test (falsify / confirm) Data
- Explain Data
- Help to develop Scientific hypothesis

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What are scientific facts?

Vicious circle?

- Data
  - affects
  - test (falsify / confirm)
  - explains

- Scientific hypothesis
  - predicts
  - help to develop

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Observation and Observability

• Why should we be worried about data?
  • Reliability can be questioned
  • Problem: way of access
Observation and Observability

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  • Reliability can be questioned
  • Problem: way of access

• Distinction between observables and unobservables

CMS Detector 2014

Higgs boson, event recording 2012
Observation and Observability

• What is observable?
Observation and Observability

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• Radical claim: scepticism (e.g. René Descartes)
  • Both, observable and unobservable parts of the world, are questioned
Observation and Observability

- What is observable?
- **Radical claim:** scepticism (e.g. René Descartes)
  - Both, observable and unobservable parts of the world, are questioned
- **Moderate claim:** Scientific realists (e.g. Richard Boyd) vs. anti-realists (e.g. Bas C. van Fraassen)
  - No quarrels about observable part of the world
  - Unobservable part, however, is contested
Observation and Observability

Problem of **empirical underdetermination**:
- Unobservables are **relevant parts of scientific explanations**
Observation and Observability

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- Unobservables are **relevant parts of scientific explanations**
- An example from the history of science: Phlogiston vs. Oxygen

Observable phenomenon: **Fire**

How to explain the process of combustion?

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Observation and Observability

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Explanation 1: Combustion = **phlogiston** is released by a substance
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- An example from the history of science: Phlogiston vs. Oxygen

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How to explain the process of combustion?

Explanation 1: Combustion = **phlogiston** is released by a substance

Explanation 2: Combustion = substance reacts with **oxygen**
Observation and Observability

• Many phenomena are **only accessible via instruments**
• But: **what makes the difference** between observables and unobservables?
Observation and Observability

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'Naked' eye

Using glasses
Observation and Observability

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'Naked' eye

Using glasses

Using a telescope

Using a tube full of water to detect neutrinos and, thereby, to observe mechanisms beneath the surface of the sun

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Observation and Observability

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Grover Mawell: slippery slope argument

Using a tube full of water to detect neutrinos and, thereby, to observe mechanisms beneath the surface of the sun

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Observation and Observability

• Alternative approach by Peter Kosso (1988)
  • Complexity of observational process
  • Information transmission model of observability
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Observation and Observability

Dimensions of observability
Observation and Observability

Dimensions of observability

1. **Immediacy**: Does and, if so, how does x interact with the observational apparatus?

2. **Directness**: How many interactions take place?
Observation and Observability

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3. **Amount of interpretation**: How many different theoretical accounts are needed to explain those interactions?
Observation and Observability

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2. **Directness**: How many interactions take place?

3. **Amount of interpretation**: How many different theoretical accounts are needed to explain those interactions?

4. **Independence of interpretation**: Is the theoretical approach that explains the observational data independent of the theory that is to be tested by those data?
Observation and Observability

Dimensions of observability

1. **Immediacy**: Does $x$ interact with the instrument? / Is $x$ detectable or not?
Observation and Observability

Dimensions of observability

2. **Directness**: How many interactive steps take place?

Phenomenon x

Observational apparatus $o_1 \ldots o_n$

Observational apparatus

Interacts with

Interacts with

Interacts with

Interacts with

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Observation and Observability

Dimensions of observability

3. **Amount of interpretation:** How many different instruments / theories are involved?

![Diagram showing the interaction between Phenomenon x and CERN's accelerator complex, including CMS, ALICE, SPS, and ATLAS.]
Observation and Observability

Dimensions of observability

4. **Independence**: Do we use the same theory to explain $x$ and the observation of $x$?

Phenomenon $x$  
Observational apparatus  
Observational apparatus

Theoretical approach to understand $x$  
Theoretical approach to understand function

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Theory-ladeness of observation

• Observation is a complex process, not a binary relation between observer and phenomenon
  • Ludwik Fleck (1935): Veni, vidi, vici assumption is a myth
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• No brute facts available in science
  • Relevance of interpretation, i.e. background theories
Theory-ladeness of observation

- Observation is a complex process, not a binary relation between observer and phenomenon
  - Ludwik Fleck (1935): Veni, vidi, vici assumption is a myth
- No brute facts available in science
  - Relevance of interpretation, i.e. background theories
  - “All observation in science is influenced by theory” (Kosso 1993, 113).
  - Theory-ladenness of observation seems to be unavoidable
  - Why does this matter?
Theory-ladenness of observation

- Worrisome consequences of theory-ladenness
  - Do we fabricate the evidence that we are in need of?
  - Do we generate alternative “facts”?
Theory-laden-ness of observation

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TV comedy
“Zondag met Lubach”
The Netherlands welcomes Trump in his own words: https://www.youtube.com/watch?v=ELD2AwFN9Nc
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Theory-ladenness of observation

Vicious circle if Independence condition is violated (Kosso's 4. dimension of observability)

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Theory-ladenness of observation

• Martin Carrier (1994) calls this “measuremental theory-ladenness” of observations
  • Measuring procedures are influenced by theories
  • Theories are needed to interpret data
Theory-ladenness of observation

- Martin Carrier (1994) calls this “measuremental theory-ladenness” of observations
  - Measuring procedures are influenced by theories
  - Theories are needed to interpret data
  - Problems arise if the theory used to build the measuring device is equivalent to the one that should be tested by data produced by this device
  - How can we handle this problem?
Theory-ladenness of observation

Example: The discovery of the Higgs boson (2012)

- **Indirect measurement**: theoretical assumptions guided research
Theory-ladenness of observation

Example: The discovery of the Higgs boson (2012)

• **Indirect measurement**: theoretical assumptions guided research

1. Where to look for the data?

• Instruments needed: e.g. particle accelerator working with a particular level of energy
Theory-ladenness of observation

Example: The discovery of the Higgs boson (2012)

• **Indirect measurement**: theoretical assumptions guided research

1. **Where to look for the data?**
   • Instruments needed: e.g. particle accelerator working with a particular level of energy

2. **What counts as evidence?**
   • Retrodiction: certain particles of decay allow inferences with certain probabilities
Theory-ladenness of observation

• Reliability considerations:
  • Special Issue “Synthese” 2017
    Vol. 194(2)
Theory-ladenness of observation

• Reliability considerations:
  • Special Issue “Synthese” 2017
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  • Statistical significance of
    the data (five sigma)
Theory-ladenness of observation

- Reliability considerations:
  - Special Issue “Synthese” 2017 Vol. 194(2)
  - Statistical significance of the data (five sigma)
  - Usage of different ways of access: different kinds of detectors at different experiments
Theory-ladenness of observation

• James Ladyman (2002): argument in favour of unobservables
  • At least some of them are detectable via instruments
  • “The greater the extent to which detections can be corroborated by different means [different instruments / methods], the stronger the argument for realism in connection with their putative target.”
Theory-ladenness of observation

• James Ladyman (2002): argument in favour of unobservables
  • At least some of them are detectable via instruments
  • “The greater the extent to which detections can be corroborated by different means [different instruments / methods], the stronger the argument for realism in connection with their putative target.”
  • It would be miraculous if different detective devises show the same results, in case there was no real entity causing those results
Social dynamics in science

• But why do we focus on the Higgs boson and hope for „new physics“ as a by-product only?
Social dynamics in science

• But why do we focus on the Higgs boson and hope for „new physics“ as a by-product only?

• Are scientific facts different from facts in the social world?
  • Facts in the social world are dependent on human activity (politics, economics, etc.): they are produced
  • Scientific facts are independent of human activities: they have to be discovered, but are not invented
  • But: measuremental theory-ladenness calls for attention
Social dynamics in science

• Ludwik Fleck (1935), Thomas Kuhn (1962): more wide-ranging social influences in science
  • Science as a social institution bound by tradition
  • Paradigm / thought style: shared practices, background beliefs, social conventions
Social dynamics in science

• Ludwik Fleck (1935), Thomas Kuhn (1962): more wide-ranging social influences in science
  • Science as a social institution bound by tradition
  • Paradigm / thought style: shared practices, background beliefs, social conventions
  • Relevance of education and scientific training
  • Students are taught what is relevant to their community
    - What is an interesting phenomenon to observe?
    - How to observe correctly?
    - How to interpret the data?
Social dynamics in science

• Kuhn's strong thesis: scientists sharing different paradigms live in different worlds; they perceive different phenomena
Social dynamics in science

• **Kuhn's strong thesis:** scientists sharing different paradigms live in different worlds; they perceive different phenomena

• Picture Puzzle: **shift in perspective**

• Martin Carrier calls this “perceptual theory-ladenness of observation”

Wikimedia Commons: Wenzel Hollar (1607-1677): "Landschafts-Kopf"
Social dynamics in science

• But: *thesis is too strong* – communication still possible as well as revisions of faulty hypotheses

• *Nature's resistance* to unduly interpretation
Social dynamics in science

- But: thesis is too strong – communication still possible as well as revisions of faulty hypotheses
- Nature's resistance to unduly interpretation
- Example: Giovanni Schiaparelli's "Martian canals" 19th century
- Evidence of intelligent beings?
- Problem of translation: canali = channel ≠ canal

Wikimedia Commons: Schiaparelli's map of Mars, compiled over the period 1877-1886
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• Optical illusion: human eye connects faint dots into lines

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Social dynamics in science

• However, social influences are still wide-ranging, why?
Social dynamics in science

• However, social influences are still wide-ranging, why?
• Social dynamics influence choice of problems, methods, theories – in a way science is bound by tradition
  • How to get funding?
  • How to satisfy your reviewer to publish an article?
  • How to get your paper accepted at a conference?
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• Does this narrow the focus of science?
  • Case study by Michael Gordin (2012) on Immanuel Velikovsky (“Worlds in Collision”)
  • Science versus pseudo-science
But this is the topic
for another talk
in philosophy of science....
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