

# Initial Conditions, Laws and Explanation

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## Laws Fundamental and Non-Fundamental

**Basic Fundamental Laws** Specified by the axioms of the best system of the fundamental properties of the world. Call this system the SUB-SYSTEM. *Assumption:* They are the deterministic time reversal invariant laws of Newtonian mechanics.

**Non-Basic Fundamental Laws** Specified by (subsets of) the theorems of SUB-SYSTEM

**Basic Non-Fundamental Laws** Specified by the additional axioms required by the extension of SUB-SYSTEM to the non-fundamental properties of the world. Call this system the SUPER-SYSTEM.

**Non-Basic Non-Fundamental Laws** Specified by (subsets of) the theorems of SUPER-SYSTEM. *Assumption:* Non-fundamental laws include special science laws.

# Anarchism *versus* Imperialism

**Special System Laws** Specified by the axioms and (subsets of the) theorems of the best system of the non-fundamental properties of the world. Call this the SPECIAL-SYSTEM. *Assumption:* They include most of the generalisations called laws in the special sciences.

*Question:* What are the basic non-fundamental laws?

**Anarchism** The basic non-fundamental laws are the SPECIAL-SYSTEM laws (Callender and Cohen, Winsberg).

**Imperialism** The basic non-fundamental laws are those required to underwrite the second law of thermodynamics (Albert, Loewer).

## Imperialism, More Precisely

According to **Imperialism** the basic non-fundamental laws are:

**Past Hypothesis (PH)** The initial macroscopic state of the universe is one of extremely low entropy.

**Statistical Postulate (PROB)** The probability that a given macroscopic state is realised by a given microscopic state is provided by the canonical statistical mechanical probability distribution for that macroscopic state, conditional on PH.

After Albert's description of the conjunction of the fundamental laws, PH and PROB as the "Newtonian statistical-mechanical contraption", let us call this all **CONTRAPTION**. *Assumption:* CONTRAPTION is sufficient to ground the second law.

## The Argument for Imperialism: Part One

*Question:* Why believe that the SPECIAL-SYSTEM laws are logical consequences of CONTRAPTION?

- 1 CONTRAPTION makes “good empirical predictions about the values of the thermodynamic parameters of macroscopic systems” (Albert).
- 2 The empirical success of CONTRAPTION warrants belief that it is true *qua* theory of thermodynamics. (To be true *qua* theory of *X* is to truly specify the propositions that determine the objective chances of the *X* properties obtaining).
- 3 Therefore we should believe that CONTRAPTION is true *qua* theory of thermodynamics (1, 2).
- 4 CONTRAPTION has the logical consequence that probabilities are assigned to all physically possible empirical propositions and so provides a “complete scientific theory of the universe”.

## The Argument for Imperialism: Part Two

- 5 Therefore we should believe is CONTRAPTION is true *qua* theory of everything (3, 4).
- 6 The laws of the non-fundamental sciences are the propositions concerning non-fundamental properties that are assigned a high probability of obtaining by CONTRAPTION.
- 7 When propositions concerning non-fundamental properties are well confirmed as belonging to SPECIAL-SYSTEM, we have reason to believe that they have a high probability of obtaining.
- 8 Therefore we have reason to believe that the well confirmed laws of the non-fundamental sciences are logical consequences of CONTRAPTION (5, 6, 7).
- 9 Therefore the explanatory content of the non-fundamental sciences is a logical consequence of CONTRAPTION (8)

## Imperialism and Arbuthnot's Regularity

**Derivation** Specify the complete microscopic state of the world at 1623 and use the fundamental laws (in conjunction with appropriate bridge laws) to derive the exact number of male births and the exact number of female births.

**Equilibrium** Show that when certain constraints are satisfied, the equilibrium sex ratio at reproductive age in biological populations will be 1:1, that the human population in London in 1623 satisfies those constraints, and that the mortality rates of male and female children in London in 1623 differ by the ratio required to produce the equilibrium ratio.

Kitcher: **Derivation** “would not show that Arbuthnot's regularity was anything more than a gigantic coincidence”

## Imperialism and Arbuthnot's Regularity

Albert and Loewer: Presuppose (5) and argue from (6) and (7) to (8). Interpret Kitcher as affirming (7) while denying (8) which—given (5) and (6)—is simply inconsistent:

“it gets hard to see what Philip can possibly have had in mind in supposing that something can amount to a ‘gigantic coincidence’ from the standpoint of [CONTRAPTION] and yet (somehow or other) *not* be”  
(Albert)

“if a regularity is lawful then it must also be likely and [CONTRAPTION] is the arbiter of what is likely”  
(Loewer).

## (1-3) What does CONTRAPTION Explain?

*Objection:* There is a simpler theory sufficient to explain thermodynamics and so it should be believed in lieu of CONTRAPTION:

**SM-PROB** The probability that a given macroscopic state is realised by a given microscopic state is provided by the canonical statistical mechanical probability distribution for that macroscopic state.

*Reply<sub>1</sub>:* SM-PROB is falsified by the low-entropy past.

*Reply<sub>2</sub>:* SM-PROB is falsified by (e.g.) the locations of spatulas.

## (1-3) What does CONTRAPTION Explain?

Albert:

**SM-PROB** Falsified by the locations of spatulas. (*Note:* Only if SM-PROB is a theory of spatulas).

**CONTRAPTION** Confirmed by the locations of spatulas.

Objections:

**Leeds' Lake** I dip my bucket in the lake while observing that the rest of the lake contains ice. CONTRAPTION predicts the bucket will not contain ice.

**Aliens** Consider the hypothesis that powerful and crafty aliens moved all the spatulas and then destroyed themselves. Does CONTRAPTION *alone* really assign **Aliens** low probability?

## (3-5) Is CONTRAPTION The Theory of Everything?

*General worry:* Weak inductive evidence. *Specific worries* (Callender and Cohen):

- State Space** The state spaces over which the probabilities in the non-fundamental sciences are defined are typically parameterized with respect to different variables.
- Open Ended** The class of fundamental properties realising some non-fundamental properties may be open-ended and so incapable of being captured by a Lebesgue measure (Fodor).
- Improbability** Some SPECIAL-SYSTEM laws may be improbable by the lights of CONTRAPTION (Kitcher).
- Autonomy** Failure to respect the metaphysical autonomy of SPECIAL-SYSTEM laws.

## (3-5) Is CONTRAPTION The Theory of Everything?

Consider an event  $A$  which involves the instantiation of a non-fundamental non-thermodynamic property. Suppose SPECIAL-SYSTEM contains a generalisation  $S_1 \rightarrow S_2$  that assigns probability  $P_{ss}(A)$ . Suppose CONTRAPTION assigns probability  $P_c(A)$ . *Questions:*

- Q1 Why believe  $P_c(S_1 \rightarrow S_2) \approx 1$ ?
- Q2 If  $P_c(S_1 \rightarrow S_2) \not\approx 1$ , is  $S_1 \rightarrow S_2$  nevertheless a law?
- Q3 Why believe that in general  $P_{ss}(A) = P_c(A)$ ?
- Q4 If  $P_{ss}(A) \neq P_c(A)$ , which should be used for  $A$ -inferences?  
(Or: which assigns the correct  $A$ -chance?)

Q4 is *not* Hall's puzzle, but it *is* the reference class problem, and it arises elsewhere (e.g. in characterising the reference environment for biological fitness).

## An Argument for Anarchism

*Argument for CONTRAPTION:* If we knew the exact initial condition and the fundamental laws PH and PROB would be redundant. Not knowing the initial condition, we infer that it is probably one that grounds the inference to thermodynamically typical behaviour.

*Transposed Argument for Anarchism:* If we knew the exact initial condition and the fundamental laws SPECIAL-SYSTEM would be redundant. Not knowing the initial condition, we infer that it is probably one that grounds the inference to typical SPECIAL-SYSTEM behaviour.

## (5-8) Are All and Only the Laws Likely?

Which are the macrostates relative to which the probability of the SPECIAL-SYSTEM generalisations obtaining is high?

- Horn<sub>1</sub>** Many, if not most, laws above the level of biology are highly contingent relative to CONTRAPTION and all macro-states prior to their initial instantiation (Gould, Beatty). Therefore there is no single macrostate relative to which the probability of SPECIAL-SYSTEM is high.
- Horn<sub>2</sub>** The natural move: “Let’s say that the special science laws that hold at  $t$  are the macro-regularities that are associated with high conditional probabilities given the macro-state at  $t$ ” (Loewer). Now we have trouble distinguishing law-like and accidental generalisations without resorting to SPECIAL-SYSTEM.

## (8-9) Reduce the Laws, Reduce the Explanations?

**Autonomy** There is a dimension of explanatory depth along which non-fundamental explanations are deeper than fundamental explanations.

**Generality** Generality of laws *versus* generality of explanations.

**Abstraction** Measure of the range of possible situations to which an explanation applies. *Proposal*: More abstract explanations are in an important sense explanatorily deeper, therefore **Autonomy** is true.

## (8-9) Reduce the Laws, Reduce the Explanations?

Examples:

**Arbuthnot's Regularity** Equilibrium is more abstract than Derivation.

**Thermodynamics** Thermodynamic explanations are more abstract than microphysical explanations.

*Claim:* The range of possible situations relevant to determining the degree of abstractness of an explanation includes physically impossible situations. For example, situations with different laws of physics (*Note:* this is not a claim about the truth of certain counterfactuals).

*Upshot:* The explanatory content of SPECIAL-SYSTEM cannot be reduced to CONTRAPTION.