# Popper, Bayes and the inverse problem

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Using observations to infer the values of some parameters corresponds to solving an 'inverse problem'. Practitioners usually seek the 'best solution' implied by the data, but observations should only be used to falsify possible solutions, not to deduce any particular solution.

As w n m [1], y m s i s s i ns. An ny n m s ss i i ns nn n y is , n sin w n i i n si s y, s i in i s m i i n , s m i m s, i s m n y n . sin ys i y i in s s s i ns s n s s in w m in m. Th i si i n, sin s m s m n s in s m s s n in sys m, s n s in s m in m. s w m s (in n n- n m ys i s) ni s i n, s s i y in i , in s m m y m ny s i ns w n m n m s sys m i si m s i ns, n s i n (in ns i s n ). Th is is w y s i m m i y is s m i sin s ms.

## FORMALIZATION OF THE INVERSE PROBLEM

Th in n s s m m s s n s i ns is, s , s s n i i s i n , i w s n y in 1760 1810 s m i i ns s [2]. Th w si ms i m w s i s i m s E , n s s n m in i s n s n m s.

Th m w s n s s n i m i n m: w i s m m s s i ns? i s m s i n i s s (B s i n ) w m m m in s m s m s s - s - s m s i n i s s n G ss) w m m m in s m s s m s s - s m . I s n m w m s w m n y s i s s i i n s i n s i ns, i n i s i i n f(x) ( x ) i in s s - s - s m , n ss i n i s i n f(x) ( x²) i in s s - s m . y, w m m n i y s - s m , w s s - s - s m , i s n ny s i m n in in in y i s s, s in s - s s m n y in s s s i m in ; s in s - s - s m i s m m m i ns (s s in m m n ). I is w y n w s - s - s i i n i s m ss s ns i n s s s s n n n s in ( y s n ss).

Th In n i n n i n n i i n (I ) is in m m n in [3] ss i n n in y in s



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## THE NEED FOR DEEPER UNDERSTANDING

## SHOULD *A PRIORI* INFORMATION BE USED?

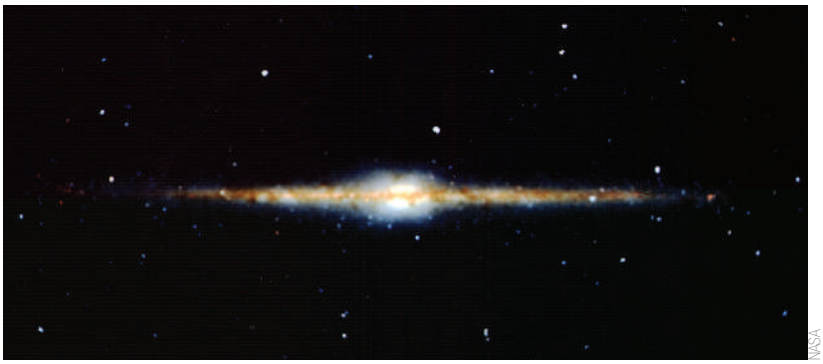

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Figure 1 **Sideways. An edge-on view of our galaxy, the Milky Way, taken by the Cosmic Background Explorer (COBE) satellite. How many models are consistent with the measured luminosity?**

**FINDING A NEEDLE IN A HAYSTACK IS HARD IF THE HAYSTACK HAS HUNDREDS OF DIMENSIONS**



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Figure 2 **Giant 'haystack'. Seismometers placed on volcanoes record complex seismograms, most of which do not agree with available models. The search for the needle in the haystack continues.**

## PROGRESS BY FALSIFICATION

In i i n y si n , is n i i in i n s m *a priori* in m i n n sys m, in i i n n ini s ny m s m n ; w n sin i y n s is m y in m ss nsi y n E , w s *a priori* in m i n w in w n i n y i ss , w i w s n *a priori* n m ss nsi y. F s m si m ms, is ; s s n i mi i n i m is in in s si mi s s y n G ss, w i i s i n ( s m ') n n s i m i n s ( n s w n m n m ').

B m ny y y ms, i mi i n ni s n' w s s i i i y is i i n in m m s is m ; m ny s n y i m , m , w s s s w m m y m y y i n . C nsi , ins n , y i in s m in i i n; s m s i m n y si n s s s m si *a priori* ni in m i n n w s is m ms in m s is mi s y n m i i s s s is m

w s. Th m i y m i m (w i y s, s n s n) s y m s is m ms. Th n is w : n i w s s m y y m ny m s nsis n w s i ns, n in si n n m y n in s s s n n nin i i sin n i ns i mi n i m nsi n i y s s in .

Th i s in in s m s n s inin n s' m i s isi n. A i s n is i m s s s s in n in s m nsis s s m w in in ' m m , sin ni s minis n s in si n ssin . Th is is n n ss i y i in i w w s is s in s m n m i si n i n i m: n s m , , ins , si y m s.

I s s s in , in in i , n in s m s s w: s i *a priori* in m i n s n i y m s sys m, n i y n in ni n m m. F m , s w m in m, m i i ns s i ns n s s m i i n i i is n , i n n ni i sin s i ns n , s, in ysi y in s . Th n m s n si , n m s . Th i n m s n n si s n s i n in s m.

Th is n ssin m i i n m s' s i i n m s' w in y y s B y s' i m, s i ns m s n s n s s m s i i i y is i i n n s m s s i is i i n. I s s s i s in 's in i w A s i m n ni mi y, s s in is w iffi in.


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