vari-
ables
causality :2
009offersthefollowingtwo, purportedlyequivalent, definitionsofvariables :
Byavariablewewillmeananattribute, measurementorinquirythatmaytakeononeofseveralpossibleoutcomes, orvalues, fr
f∘
S
f
Ω
S
F =
MA
F
M
A
feynman1979noted, inordertounderstandthislaw, wemustbringsomepre−
existingunderstandingofforce, massandaccelerationindependentofthelawitself.Furthermore, wecontend, thisknowle
F
M
A
re-
sults
of
mea-
sure-
ment
pro-
ce-
dures
F
M
A
F
random2003′snotionofvariablesas“consistentclassesofquantities′′thatconsistofpairingbetweenreal−
worldobjectsandquantitiesofsometype.Forceitselfisnotawell−
definedmathematicalthing, asmeasurementproceduresarenotmathematicallywell−
defined.Atthesametime, thesetofvaluesitmayyieldarewell−
definedmathematicalthings.Noactualproceducanbeguaranteedtoreturnelementsofamathematicalsetknowninadvan
−anythingcanfail−
−butweassumethatwecanstudyproceduresreliableenoughthatwedon′tlosemuchbymakingthisassumption.
F
F
F
F
F
mea-
sure-
ment
pro-
ce-
dure
B
X
B
X
Bx
B
x ∈
X
BA
A ⊂
X
∨x∈ABx
B
C
X
Bx ⟺
Cx
x ∈
X
B
B
f :
B →
C
f∘
B
C
f(x)
B
x
B
f
B
MA
h :
(x, y) ↦
xy
(M, A)
∘f)∘
Byieldsx ⟺
Byields(g∘
f)−1(x)
⟺
Byieldsf−1(g−1(x))
⟺
f∘
Byieldsg−1(x)
⟺
g∘
(f∘
B)yieldsx
M
A