# Naming Conventions for Gauge Symmetry Groups

## Introduction

Names such as U(1), SU(2), SU(3), SO(10), and E6 come from Lie group theory. The letters identify the family of symmetry groups, while the number indicates the dimension of the vector space on which the matrices act.

| Symbol | Meaning | Description |
|---|---|---|
| U | Unitary | Complex matrices preserving length. |
| SU | Special Unitary | Unitary matrices with determinant = 1. |
| O | Orthogonal | Real matrices preserving length. |
| SO | Special Orthogonal | Orthogonal matrices with determinant = 1. |
| Sp | Symplectic | Preserve a symplectic form. |
| E6,E7,E8 | Exceptional | Exceptional Lie groups. |

## Examples

| Group | Meaning | Physics |
|---|---|---|
| U(1) | 1-dimensional unitary | Electromagnetism / Hypercharge |
| SU(2) | 2-dimensional special unitary | Weak interaction |
| SU(3) | 3-dimensional special unitary | Strong interaction |
| SO(10) | 10-dimensional special orthogonal | Grand Unified Theory |
| E6 | Exceptional Lie group | GUT / String models |
| E8 | Exceptional Lie group | Heterotic string theory |

## Meaning of the Number

The number n in U(n), SU(n), or SO(n) denotes matrices acting on an n-dimensional vector space.

## Why 'Special'?

'Special' means the determinant of every matrix is +1, excluding reflections and overall scaling.

## Why U(1)?

Quantum wavefunctions may be multiplied by a complex phase $\exp(i\theta)$ without changing physical predictions. These phase transformations form the group U(1). Making the phase local requires the electromagnetic gauge field.

## Summary

The naming convention combines the family of symmetry groups with the dimension of the representation space. These groups form the mathematical foundation of the Standard Model.